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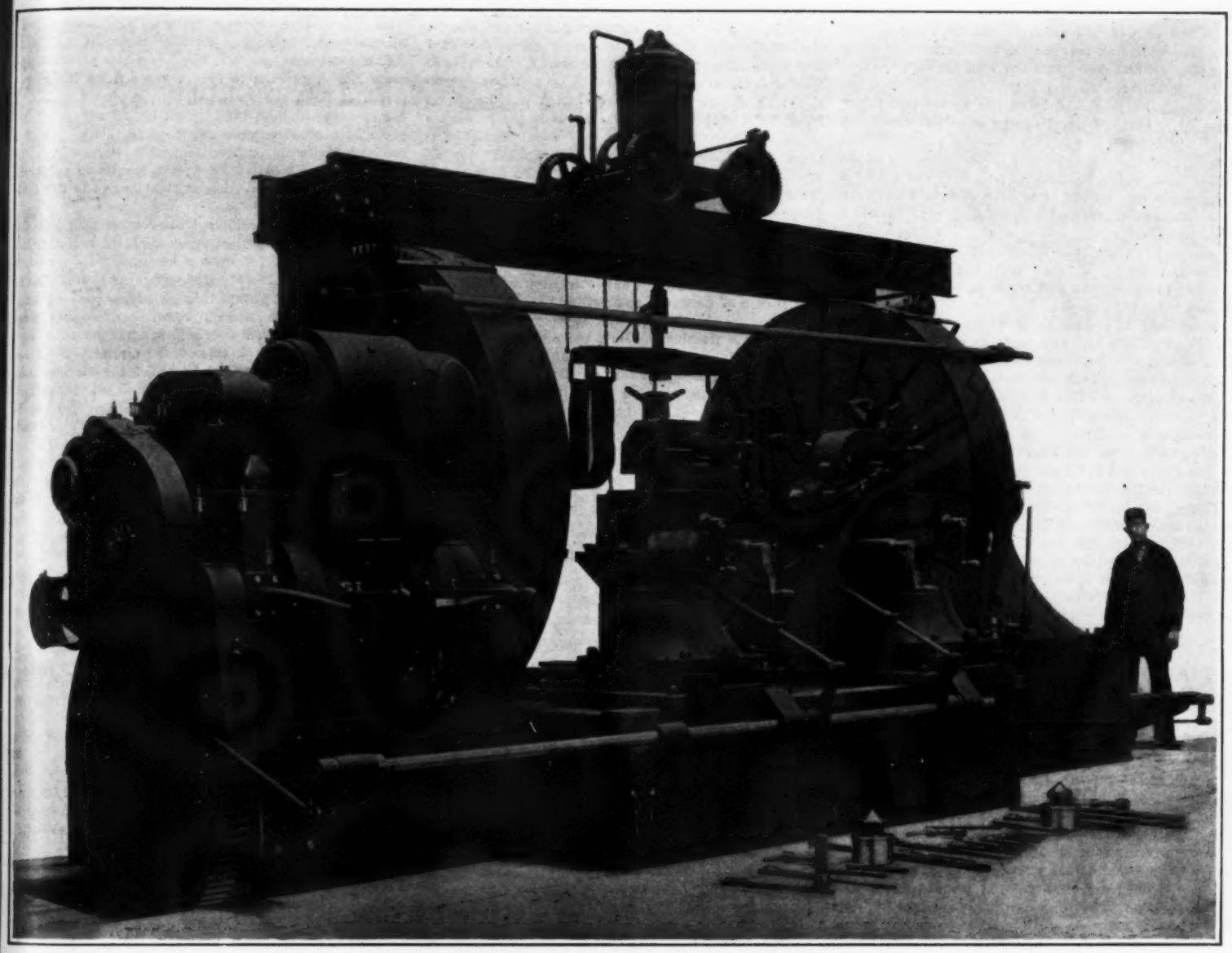


A big lathe that will accommodate wheels one hundred inches in diameter.

A Mammoth Driving Wheel Lathe

An Exceptional Machine Capable of Doing Very Heavy Work

ILLUSTRATING progress in American machine tool building the following description of a driving-wheel lathe of unusual dimensions, that was built for parties in Roumania, was published in the *Iron Age*, to which we are indebted for the illustration:

It has a swing of 100 inches, and is built along the lines of the company's standard 90-inch tool, but is arranged to handle wheels from 32 7/10 to 94½ inches in diameter on the tread, with a maximum distance between centers of 11 feet 2¼ inches. The minimum obtainable distance between the face plates is 6 feet 8 inches.

The bed, which is of massive construction, is 22 feet long. The front portion, upon which the carriages rest, is moved out 10½ inches from the main bed. Wheels with outside cranks can be rolled into the machine on tracks located on the bed, and the cranks will not interfere with the driving dogs on the face plates. The rear T-slot is extended to the left face plate to provide a place in which the bolts for the carriage can be located if a journal turning attachment should be ordered at some future time.

The face plates, which are 100 inches in diameter, are arranged with recesses for admitting the outside cranks of driving wheels. The face plates are driven by large-diameter gears bolted to their back faces. The driving gears which engage the face plate gears can be thrown out of mesh with the latter so that the speed of the left hand face plate can be increased through an auxiliary train of gears when the machine is used for journal turning. Two carriages are mounted at the front of the machine and have two extra heavy tool rests, the bases of which are arranged to swivel to give the proper angle for the taper of the wheel tread. The tool rests are equipped with pneumatic tool clamps so that the tools can be changed almost instantly. Power feed for the tool rests is provided through a rocker shaft shown at the front of the bed.

The headstock is directly connected to a General Electric 30 horse-power adjustable-speed motor, having a range of 500 to 1,500 revolutions per minute. In addition the gear arrangement provides for four additional speeds, giving a range of speed for turning tires of from 10 to 25 feet per minute for all diameters of wheels.

A convenient detail is that the spindles have noses projecting 3 inches into the face plates so that the overhang of the sliding spindle is made as short as possible when turning small wheels with outside journals.

One great labor-saving attachment provided for the lathe is a pneumatic hoist that is carried on two 12-inch channels located above the machine. The hitch to the axles is made by using two slings made of belting, instead of the hooks that are generally employed. With the use of this hoist the wheels can be placed in position in a short time.

Berne Post Office Building

ONE of the handsomest postoffice buildings in Europe is the new one at Berne, Switzerland, and a good part of the work, at least as regards the framework of the building, was done in reinforced concrete. It is in fact a veritable palace, and its construction cost $550,000 for a structure of moderate size. The expense for the reinforced concrete work which figured $40,000, was somewhat more than usual on account of the large factor of safety which the administration stipulated. On the whole, the undertaking, carried out on the Hennebique system, adds another success to reinforced concrete work.

Advances in General Physics*

Notes on Several Branches of Science in Which Our Knowledge Has Increased

In general, lectures and papers on physical subjects deal with only one feature of science, and in listening to them, or in reading the reports of them, we are apt to forget how general is the advance in all other branches. It was a somewhat novel experience to find Prof. A. W. Porter of Chicago University, speaking before the Royal Institution on several unrelated subjects under the title of "Advances in General Physics," the only connecting-link between the various matters being that they all had been connected with his own work.

Having referred to the extraordinary development that physical science had taken during the last thirty years, after having appeared to be an almost completed story which needed only to be worked out in certain details, Prof. Porter spoke first of the radiation pressure of light, which he demonstrated with the aid of a very simple apparatus. It may be described (Fig. 1) as a flat needle, provided with two pairs of wing-like projections and a mirror disk below. The upper wings are disks, 1 centimeter in diameter, in the plane of the needle and directly attached to it; the lower disks are attached to short arms, and are in planes at 45 degrees to the plane of the needle. The needle is about 5 centimeters long; it is suspended within a bottle-shaped evacuated glass vessel by a long quartz thread, and a horizontal glass tube, fixed below the mirror and drawn out on both sides, acts as a damper. The needle and disks are made of silver foil, both surfaces being precisely alike. The radiation pressure, Prof. Porter explained, was small; but the experimental difficulties arose chiefly from the fact that there were spurious effects which had to be guarded against. The ordinary Crookes radiometer did not spin by reason of radiation pressure, but owing to temperature differences set up by the light in the walls of the containing vessel and in the residual gas. The radiation pressure had actually been demonstrated by Lebedew in 1900, and simultaneously by Nichols and Hull. Exhibiting the curves of the latter, Prof. Porter showed that, with different gas pressures in the vessel, the effect might be very different. But there was always a first, instantaneous push (the real radiation pressure) or change of zero, followed by a slow, creeping effect, which might be much greater and of the opposite direction (repulsion or suction), or might be smaller; in the apparatus of Nichols and Hull, for instance, there was hardly any spurious effect at a pressure of 19 millimeters. The radiation pressure was general for any wave falling upon a plane, and was of fundamental importance. Its nature might be understood from the following consideration: Imagine a stretched string (Fig. 2) under a tension T set in vibration, and a card pushed over the string; when the vibrating string formed the angle θ, with its direction at rest, the longitudinal component of T would be $T \cos \theta$, and the force $(T - T \cos \theta)$ would tend to push the card back. That component, always positive, was the radiation pressure, and the other component would be the much smaller tangential force, which would come into play when the incidence was not normal, especially at 45 degrees, and when the surface was not perfectly polished. This tangential pressure had been studied particularly by the late Prof. Poynting. The total light pressure of the sun's radiation on the earth amounted only to six million kilogrammes ($6 \cdot 10^6$ kg.); how small that was would be understood if one considered that the attraction of Jupiter on the earth amounted to $2 \cdot 10^{16}$ kg., and that of distant Neptune even to $3 \cdot 10^{13}$ kg.

Turning to another fundamental advance of recent years, low temperature research, Prof. Porter remarked that the atomic heat (product of specific heat and atomic weight) was, at ordinary temperature, nearly the same (about 6) for all the elements, but it decreased at different rates for different elements as the temperature was lowered. At 90 deg. Cent. absolute it had, in the case of copper, only half of its value at ordinary temperature. To demonstrate this, a block of copper was provided, with a hole into which an electric thermometer was inserted. This block was exposed to the rays of an arc lamp, and the number of seconds was counted which was required to heat the copper (by the rays) through 1 deg. Cent. This block was then lowered into liquid air until properly cooled, which took some time, because the copper and liquid air did not really come into contact, owing to the spheroidal state; the block was then raised again, or rather the Dewar cylinder with liquid air was lowered, and once more exposed to the beam which, as before, was directed down the cylinder from above. Exhibiting curves of the diminution of the specific heat with falling temperature, Prof. Porter stated that the explanation of the phenomena had seemed to necessitate the adoption of the revolutionary view of the quantum theory of energy. Silberstein had, however, suggested another explanation.

As absolute zero was approached,, the electric resistance of metals, like the atomic heat, dropped to zero, steadily in some cases, very slowly finally in others; the resistance of mercury had a very abrupt fall at 4 deg. Cent. absolute. At absolute zero a body had no specific heat, no electric resistance, no expansion coefficient; an electric current once started would flow on indefinitely. Other important changes in the properties accompanied the melting of solid bodies. The specific energy of a body in a fused state, Prof. Porter remarked, was greater than that of the solid body at the same temperature; that was the meaning of the latent heat of fusion. When a metal like sodium was heated, he had found, the specific electric resistance rose as the temperature was raised, and there was a sudden increase of nearly 0.4 of its value in the resistance at the melting-point of sodium. That increase was still greater in the case of mercury; mercury was solid below — 40 deg. Cent., and when it was slowly allowed to get warmer in a freezing mixture, the resistance suddenly rose to nearly four times its value at the moment when the mercury melted. Almost exactly the same figures were found for the changes of the thermal conductivity of those two metals, and that was rather striking when

Fig. 1.

Fig. 2.

one remembered that, not so very long ago, thermal conductivity had been ascribed to molecular movements, and electric conductivity to something of an altogether different nature. When a long bar of metal was heated at one end, so as to be partly solid and partly liquid, the two portions gave different conductivity curves.

Prof. Porter then showed his heat-jacket experiment. Short lengths of glass tubes, some thin, some stout, had been pushed over a platinum wire, and fused to the wire. When the wire was heated by the electric current the covered portion remained dark, so that this overcoat kept the body cold, instead of warm, and apparently assisted in letting the heat escape. The explanation was that the variation of the escape of heat depended in part upon the increase in surface and in part upon the diminution of the surface temperature. There were, therefore, two effects opposing one another, and the result was that there should, for every jacket substance, be a critical radius of the outer surface, at which the resultant effect changed sign. As long as the jacket radius kept below this radius, heat was assisted in escaping; when the critical radius was exceeded, heat was kept in. The critical radii were: For glass, 8 centimeters; slate, 16 centimeters; rubber, 1.3 centimeters; silk, 0.7 centimeter; cotton, 1.8 centimeters; magnesia, 0.5 centimeter; asbestos, 1.9 centimeters; different kinds of asbestos differed very much, however, and for ordinary asbestos lagging 0.5 centimeter was a more correct value. For this reason the glove kept the wrist warm, but let the fingers grow cold. The temperature had not a very marked influence. Since, however, the two effects opposed one another, a thick and a thin lagging on steam pipes of the same diameter might have the same resultant effect, as Prof. Porter explained with the aid of curves. The effect was important, and its further study in the National Physical Laboratory had led to a complete modification of the wiring rules.

Turning to light phenomena, Prof. Porter showed the influence of small particles on scattered (reflected) and transmitted light. A tall cylinder was charged with a clear solution of sodium hyposulphite to which a little acid was added; the solution slowly became turbid, owing to the deposition of sulphur particles, and appeared bluish when illuminated from above. When the same experiment was made in a glass cell, placed in front of an arc-lamp, the transmitted light appeared yellow and then turned red or pink (sunset effect). As the particles of the sulphur grew larger, the turbidity increased too much to allow any light to pass; after some minutes light was again transmitted, appearing now bluish; this secondary phenomenon was not fully understood yet. According to Rayleigh the scattering was inversely proportional to the fourth power of the wave-length, and as blue light had half the wave-length of red light, it was 2^4 times more scattered than red light; hence the sky, which we should not see otherwise, looked blue. Smoke and skim milk looked blue for the same reason; any particles would do, the material did not much matter, but when the particles became bigger, growing to two or three times the wave-length of light, the scattered light appeared red, and the transmitted light blue. Both the effects for small particles could simultaneously be seen in the cylinder, the blue in the upper part, the red in the lower. The scattered light was polarized; the maximum polarization occurred in a direction at right angles to the incident light.

Prof. Porter also exhibited his color-mixing box for physical and physiological studies. Light entering the box through a slit fell upon a lens and then upon two prisms, and the deflected and separated beam left the box, after having passed through diaphragms directly, or through a triple slit in a screen provided with three parallel adjustable slits. The arrangements were such that a disk, white or colored, was produced on the screen, this disk being an image of the circular diaphragm in the box. When a very small prism was held in the beam (without the triple slit) two disks were seen, the prism giving one disk of some particular shade (depending upon the position of the prism in the beam), while the other disk showed the complementary color. Very beautiful color shades were produced, and it was impossible to tell from the appearance which was the pure color and which the combination. Prof. Porter concluded by showing some physiological color effects, old and new, due to fatigue of the eye.

* From *Engineering.*

Protection Against Insect Pests

The *Pharmaceutische Zeitung* enumerates the following prevention and remedies which have been recommended in Germany for insect-pests affecting soldiers in the trenches. Many of these are well known, but it is useful to have the various remedies compared:

Asafetida.—Not very suitable on account of its disagreeable smell.

Aniseed, worn in small bags round the neck, is very effective. The volatile oil in 30 per cent solution is also generally employed.

Anisol (phenyl-methyl ether) has been found by Prof. Fränkel (Vienna) to kill lice quickly, and to be superior to anise oil. Large quantities are being made in Austria for the use of the troops.

Benzine.—Dangerous to use and bad-smelling.

Bergamot Oil.—Specially recommended by Dr. Galewsky. It is employed as a 15 per cent solution in alcohol.

Carbolic Acid.—Very effective in aqueous solution.

Cresols recommended by Herxheuner in the form of a powder containing 3 per cent of tricresol.

Ether.—Very effective, but dangerous owing to its inflammability.

Fennel employed like aniseed, also in the form of fennel oil.

Insect-powder is not without danger if employed in large quantities.

Menthol.—Insects are kept away if a menthol-cone is applied to boots, socks or body-linen.

Mercury.—The ointment has lost much of its popularity, and is not without danger if used freely. Mercury and chalk (1 and 4) in little bags is recommended to be worn as an insectifuge.

Naphthalin used in the form of powder, ointment and alcohol solution (3 per cent).

Naphthol used in alcoholic solution (2 to 3 per cent).

Pepper is recommended by Rabe in the *Deutsche mediz. Wochenschr.*

Petrol.—See Benzine.

Sulphur.—Strongly recommended by Dr. Eyssel. Should be dusted on the linings of clothes. The action of the sweat produces small quantities of sulphuretted hydrogen, to which the efficiency of the remedy is due.

Turpentine.—Prof. Thomas von Marschalks states that rectified turpentine oil kills insects instantly. It may be diluted with alcohol or used in the form of an ointment containing 50 per cent.

Volatile Oils are useful, especially those of anise and fennel (g. v.).

Xylol has no advantages over benzine.

A. Niemann, in an article in the *Zentralblatt für Pharmazie,* recommends a mixture of salol and sulphur.—*The Chemist and Druggist, London.*

Evolution of the Pulp and Paper Industry

Achievements in an Industry Typical of Modern Chemical Engineering

By Thomas J. Keenan, F.C.S., Secretary of Technical Section of the American Paper and Pulp Association

WITHIN the period covered by the existence of the *Scientific American* no other well-established manufacturing enterprise, save perhaps the steel industry, has expanded so rapidly or developed so enormously as the pulp and paper industry. It must be noted as a remarkable feature of paper-making history that, in basic processes, the principles of paper making have undergone no essential change during centuries of application. Paper remains what it was in the days of the Crusaders, or earlier, "an aqueous deposit of vegetable fiber."

The utilization of wood as a source of fiber, and the consequent evolution of paper-making machinery mark the beginnings of a colossal development in a business, which according to the Census of Manufactures for 1909, the latest report available, employed a capital of $409,348,505, and manufactured products of a value estimated at $267,656,964, giving employment to an average of 81,473 persons, of whom 75,978 were wage earners. The per cent of increase of capital within the space of ten years from 1899 to 1909 was 144.4; value of products 110.2, and persons engaged in the industry 53.7. The same rate of increase has not been maintained since 1909, though the period from 1909 to 1912 was one of unparalleled expansion, chiefly, however, in the Dominion of Canada, toward which the pulp industry, and particularly the manufacture of ground wood pulp, has been gravitating of late years, partly as a consequence of our tariff policy, but principally through the exhaustion of pulpwood forests within the borders of the United States.

Although ground wood pulp had been known since 1840 when Frederich Gottlob Keller took out letters patent in Germany for a wood-pulp grinding machine, the process of manufacture was not developed and applied for producing paper suitable for newspapers until a much later date. It began to be used commercially about the time of the discovery by Benjamin C. Tilghmann of the disintegrating action of sulphurous acid upon wood, which resulted in the invention of chemical wood pulp by the sulphite process.

During the years that have elapsed since its introduction, comparatively few changes of importance have been made in methods of producing mechanically ground wood pulp. The logs of wood are still pressed against a revolving grindstone over which water flows, both to prevent carbonization and to carry off the resulting stream of pulpy fibers torn from the stem. Great economies of power, labor and space have, however, been effected by the use of new and improved forms of grinders. The rate and uniformity of production have been increased, especially by the use of tall magazine grinders introduced from Germany within the past three years. Grinders of the magazine pattern hold twelve cords of wood which are sufficient to keep the stone engaged for a twelve-hour grinding period. The feed of the stone to the grinder box is regulated automatically by hydraulic cylinders operating on each side of the stone, so that the grinding operation may be continued during an entire nightshift without attention.

A new order of things in paper making was ushered in with the introduction of chemical wood pulp. Then began the evolution of an industry typical of modern chemical engineering. After Tilghmann in America had pointed the way, George Fry and his collaborator Ekman developed at Bergwick, Sweden, the process of separating the cellulose of wood by boiling it under pressure in an aqueous solution of sulphur dioxide in which magnesium sulphite was dissolved. In the Ekman process, as first worked in this country in the mills of the Richmond Paper Company at Providence, R. I., in 1885, the liquor used for cooking wood consisted of an acid solution of magnesium sulphite, the magnesia being obtained by burning magnesite imported from Greece.

Mechanical difficulties surrounded the operation from the outset, though the quality of pulp produced was excellent. The digesters in which the wood was cooked were lined with lead, and the heat developed in the acid liquor proved to be exceedingly disturbing, as while the lead expanded during the application of heat, it did not contract again when cold. The cost of repairs to digesters necessitated by the behavior of the lead lining was heavy, amounting to $10 a ton on the total production. The difficulty was overcome by the invention of a digester lining composed of heavy cement backing faced with brick, the latter being pointed with litharge and glycerin. The invention of a digester lining was one of the important early contributions of the chemical engineer to the development of the industry.

The magnesium bisulphite process, originated by Ekman in Sweden, and developed by Charles S. Wheelwright and his brothers in this country at the Richmond Mill in Providence, R. I., has been modified in several important particulars, the chemical solvent now employed being bisulphite of lime. Many different kinds of pulp are obtained according to the system of cooking employed, the concentration of cooking liquor, time of digestion and the pressure employed.

The sulphite process of cooking wood is not applicable to all woods. It works best with spruce and coniferous woods generally. The Mitscherlich system of sulphite cooking, yields a product by prolonged digestion in a weak solution of sulphurous acid under low pressure. The resulting pulp is remarkable for strength of fiber. The wood is steamed for a few hours before being boiled with the acid liquor. The Rittner-Kellner quick-cook process is an improvement on the other processes, and is the one generally used in this country.

Perhaps the most important invention in pulp-making processes, especially in view of recent work in the utilization of waste wood, dates from 1883 when Dahl introduced the sulphate process for the treatment of straw, a modification of which is now applied to the production of pulp from coniferous woods that are not amenable to other treatments. The operation of boiling in this process is carried out with a solution of caustic soda containing small amounts of sulphate and sulphide of soda. The sulphate of soda does not affect the wood and is used as a source of alkali and sodium sulphide. The principle of the process depends on the fact that in soda recovery when the concentrated liquors are burned to ash, the sodium sulphate is reduced to sulphide by the carbonaceous matter derived from the wood, while the soda in conjunction with the organic matter is converted into sodium carbonate. The liquors are causticized in the usual manner, the lime converting the carbonate into caustic soda and having little action on the sodium sulphide.

The manufacture from sulphate pulp of strong brown wrapping paper, known in the trade as kraft paper, gives promise of a tremendous development in the Southern States, where there are immense quantities of yellow pine waste lumber excellently suited for conversion into pulp by the sulphate cooking system. According to figures compiled by G. F. Steele, of the American Paper and Pulp Association, sulphate pulp is imported from Norway and Sweden to the amount of 35,965 tons annually, and kraft paper to the amount of 10,250 tons, while the estimated imports from other countries is 12,085 tons. When it is considered that sufficient waste wood is available in our Southern States for the manufacture of 10,000 tons of this paper a day the opportunity that exists for the development of the industry needs no further demonstration. Kraft paper is now being made in Canada and in some of our Northern States at the rate of about 250,000 tons annually, and with the extension of the industry in the South we should soon be economically independent of other countries so far as this class of paper is concerned.

In the United States the development of the paper industry to its present proportions has taken place most rapidly within the past quarter of a century, for it is within that period that the evolution of paper-making machinery has been characterized by the greatest increases in size of units and consequently of productive capacity. From fourdrinier machines making news print paper of a width of 90 inches at a speed of 200 feet a minute, the fourdrinier parts have been lengthened and widened until to-day paper machines are actually in operation which have a width of 202 inches and are capable of being speeded up to 700 feet a minute.

In Germany, the improvements in paper-making machinery and in pulp mill equipment have kept pace with the general progress of invention in the arts and sciences characteristic of that country. Prior to the outbreak of war newsprint machines had been contracted for to run at a speed of 1,000 feet a minute, each being equipped with wires of 204¼ inches maximal width. These were and are to-day the largest paper machines yet ordered in the world.

The nearest approach to perfection in paper-making machines that has been attained in Germany was exhibited last year at the International Exhibition of the Book and Graphic Industries in Leipsic. The exhibition machine was not distinguished by great size or productive capacity, the fourdrinier part being only 65 feet long with a wire width of 106 inches, while its speed of production was limited to an extreme of perhaps 600 feet (525 feet normal), but the equipment of the parts represented the last word in machine design, including a "shake" of American construction with some essential improvements. It is permissible to mention the adoption by European paper machine builders of certain American inventions, as it goes to show how the engineering features of paper making have developed in the United States during recent years. Paper-making machines of American construction have been accepted as models by a number of European machine builders, and a considerable export business is done by American manufacturers of accessory apparatus, such as refiners of the Jordan-Marshal type and pulp screens.

With the progress of invention in machinery and accessory apparatus there has been a constant improvement of product, necessitated in part by developments in the printing art, which call for a great variety of papers of different qualities, which must be sold at a low price, notwithstanding a constant increase in prices of raw materials. The introduction of scientific methods and management in the paper industry during the past quarter of a century has made this possible. In 1879 the average price of all paper was $122 per ton, and in 1909 the cost per ton to the consumer was $56.

Making Munitions of War in England

OWNERS of engineering works of all kinds are keenly, nay, vitally, interested in the new Act of Parliament, which gives the government power to take over any works or factories that might be considered suitable for the manufacture of munitions of war.

The position is indeed strange and unprecedented. No factory owner knows but that to-morrow he may be peremptorily ordered to cease his present manufacture, to obtain a new plant, and to commence the production of articles of a kind totally different from those which form the normal output of the factory.

Already this has actually happened in the case of certain motor factories, but in the majority of these instances the alteration in the nature of the output was made early in the war and not infrequently at the direct request of the firms concerned. The latter anticipated that the war would result in a great slump in the demand for private motorcars, and therefore urged upon the government their ability to manufacture certain essential portions of shells and other parts needing great precision in manufacture, such as that which normally obtains in a motor factory, where the mechanics work to finer limits than is the case in any other branch of the engineering industry. Many firms were given special work of this character, though others were advised to alter their output only to the extent of producing heavy instead of light motors.

Under the new law it is conceivable that, for example, torpedo motors might be ordered by the government to be made, let us say, at a works normally engaged in the production of motorcycle engines. In general it may be assumed that the changes in the nature of the output will be made as far as possible to harmonize with what has been done in the works before, so that the experience of the workmen in handling certain machines and materials may be utilized to the best extent. Thus we should not expect to find rifle parts being made in a works devoted to boiler construction, though it would not come as a surprise to learn that at the latter mines were in course of manufacture.

With regard to the production of ammunition for rifles and guns, this interests the engineering works proprietor to the extent of the metal cases, bullets, and projectiles for such ammunition, the manufacture of the necessary explosives coming primarily within the purview of chemical firms, many of whom could change the nature of their output without great difficulty.

In the Birmingham metal trade there are plenty of firms perfectly familiar with the working of sheet brass, who, if they were able to obtain the necessary machinery, could soon set their men to work on the manufacture of cartridge and shell cases, as well as of nickel-cased bullets. To extemporize in the matter of the production of shells would not be so easy a matter, and probably the solution of this problem lies in the continuous expansion of existing works, though many entirely new enterprises in this direction are rapidly maturing.—*The London Daily Telegraph.*

Making Zinc in Japan

LARGE quantities of zinc were formerly imported into Japan from Germany; but, as the price rose to a prohibitive figure on account of the war, and as at the same time the cost of zinc ore from the Siberian mines fell considerably, a new refining plant is being put up, and Japan will produce its own supplies, having arranged for the required ores at the mines.

Harvesting Ice

New Methods of Cutting, Storing and Shipping the Natural Product

By Wm. H. Malia

FEW readers are aware of the great changes that have taken place in recent years in the methods of cutting, storing and shipping natural ice to market.

Three years ago big ice fields in the East all looked alike in harvest-time. There was the wooden ice house with the endless chain or conveyor leading to it from the lake, and from the foot or apron of the conveyor a long canal led out through the ice, a half-mile or more, and all along it men with hooks passed the ice cakes through to the conveyor, which carried them to the houses and delivered them to the various rooms. Along the canal men were numerous, and at the far end of the canal horses hitched to plows with saw-like blades moved to and fro over the field cutting the "floats" into cakes usually 22x32 inches and about 1 foot thick.

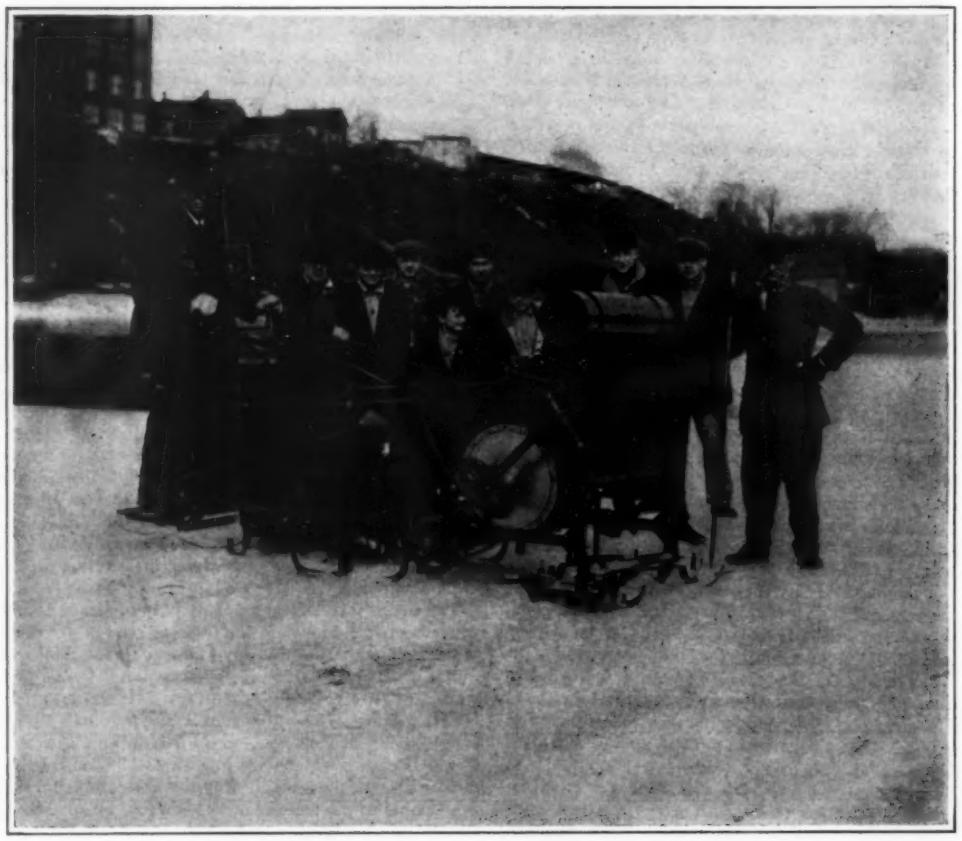
On the new field horses are as scarce as they are in the Subway, for power-driven machines have now taken their place. First, the ice is cleared of snow by a gasoline-driven scraper and then a gasoline-power plow is put to work. This consists of a frame supporting a gas engine that is carried on steering shoes in front and is driven by a traction wheel further back. Behind the traction wheel is a large circular saw, driven by the engine, and as the plow is propelled over the ice it cuts the field into great floats 16x16½ feet. These floats are led through a canal to a sawmill where they are received first by a set of 8 saws, electrically driven, which splits the float into long, narrow strips. These then pass through an L-shaped box to a second set of 5 saws, which cuts the strips into cakes. The float, 16x16½ feet square, is thus reduced into 54 cakes, each 22x32 inches. The saws pass these cakes along to the conveyors, which automatically delivers them at the rooms where they are placed in position for storage, having been thus delivered from field to house untouched by the hands of man. Incidentally, 50 per cent of labor, but not of cost, has been saved.

Nor does the scrupulous care of the modern ice man cease here. Time was when any old box-car could be "spotted" by a railroad in front of the lowering machine of an ice house, and the sawdust-covered cakes were piled pell-mell into it, regardless of its condition or previous use. To-day the cry of the iceman is for solid refrigerator cars, but whether refrigerator or just box-cars, they are thoroughly swept and then washed out—ceiling, floors and sides—before being loaded. And the sawdust-covered cakes, as familiar as the old oaken bucket, they are no longer in evidence at an up-to-date ice plant. An example of the ice house of New Ideas is a 90,000-ton house at Lake Hopatcong, built of glazed hollow tile with steel reinforcement. It has a double foundation laid below the frost-line, and not only insulation of paper and sawdust in the side walls, but it has a "sealed roof," that is, a tight loft with paper and sawdust insulation; but no covering of any kind is put on the ice.

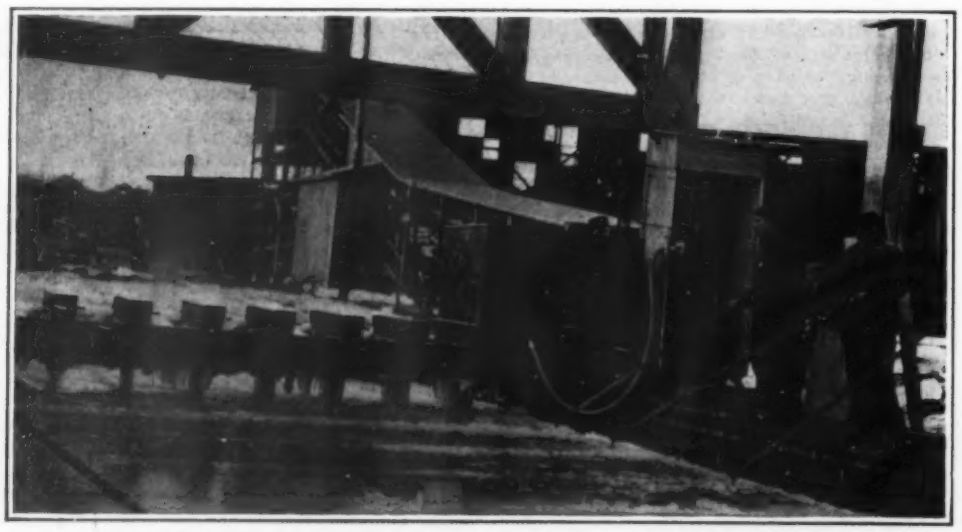
In Spring and Summer the cakes go fresh and clean and even-sized to the newly-washed car. When all cakes are in they are covered with a specially prepared paper, and thus they reach the market, or at least they reach the "ice bridge" of the cities in perfectly sanitary condition.

After all this precaution, this scrupulous nicety of sanitation, small wonder that M. J. Rosenau, Professor of Preventive Medicine and Hygiene of the Harvard Medical School, Boston, said, half in jest and half in earnest, in an address before the Natural Ice Association of America: "Who knows but that the time may come when ice will be delivered in single service packages as breakfast foods now are; perhaps these packages will be brought to our door in a nickel-plated automobile quite as attractive to look at as a florist's wagon, and delivered by a driver and striker in livery and gloves. The refinements of cleanliness are only limited by the purse and palate of the consumer—and the advertising acumen of the dealer. Once educate the people to attractive methods, even though extravagant, they will never go back to the old ways."

This work of educating the people referred to by Dr. Rosenau, and of educating the icemen themselves, has been very seriously undertaken by the organization referred to, the Natural Ice Association of America, comprising now about 1,700 harvesters operating all the way from Maine to the State of Washington.



Ice cutter driven by a gasoline engine.



Cutting large floats of ice into cakes by circular saws driven by electricity.

Five years ago some portions of the press and even physicians attributed so many bad qualities to natural ice, and laid at the doors of the ice business such responsibility for disease that many icemen themselves believed that natural ice was unhealthful. The largest harvesters, and some others, knew it was not, but they also knew that any assurances which they gave the public were received *cum grano salis*. They therefore presented the subject to the highest authorities, the most expert and scientific opinion obtainable, consisting of the most prominent professors of health, sanitation and biology in the country.

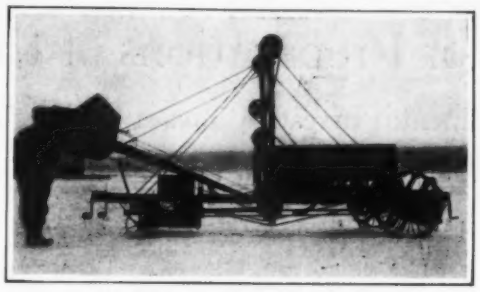
This jury of practical men and scholars was a unit in declaring that the public health has little or nothing to fear from natural ice, that water and milk are much more liable to contamination; some declare indeed that all other foods are more dangerous than ice. Dr. Porter's opinion is typical. "I must confess," he said, "that some years ago I looked at this proposition with a good deal of trepidation, and I had an idea that a man who would put ice in his glass in the Summer-time was buying a ticket to the other world, possibly. In the first place, as to most of our ice, especially that cut off of lakes or ponds where the population is not excessive, the water itself undergoes a process of sedimentation, where ordinarily 40 or 50 per cent of the solid matter probably goes down to the bottom by gravity; secondly, the water itself is so inimical to pathogenic bacteria that another 40 per cent die in the water. Now nature is taking care, you see, in the water itself, of this possibility of infection. Then when you proceed to the process of freezing, which is nature's filtration process, there you eliminate 90 per cent more, and then the cold during storage takes out about 99.5 per cent of the remaining bacteria. Now you add those percentages together and out of any given number of millions of bacteria, you might say, if you figure it, after you keep it in storage houses for another three weeks, you wouldn't have over five bacteria left in a cubic centimeter, which is a very small amount, as small as anything I can think of. And if you leave it there a month longer, those five, as tough as they are, will come to an untimely grave!"

This gives natural ice a pretty clean bill of health, at least at the ice house and on board cars when properly loaded; but how about its ultimate destination, its condition when it reaches the ultimate consumer? It is often stored in foul and filthy cellars by the push-

cart peddler; it is carted alongside of dirty coal or vegetables; it is dragged in the gutter or over unclean sidewalks on its way to house or cafe. When an ice plant asks for admission to the National Ice Association, its chemists and bacteriologists make sure that there is no pollution of the supply, and an emblem is issued which is a certification that the ice is pure and wholesome at the "bridge." There the responsibility of the association ceases. The methods of the local dealer are civic matters entirely.

Nevertheless, some things are being started. New Jersey has put a stringent law on the books as to ice selling, and Newark insists that ice must be sold from wagons used only for ice purposes and inspected by the city. Trenton has ice inspection; so has Chicago. Jersey City requires that no ice be stored underground.

Physicians tell us that a bleeding wound protects itself from contamination. Similarly ice ever melting sheds impurities or freezes germ life to death, and is safe under almost any condition; nevertheless, the one thing needed now to make it palatable and perfectly pleasing to the thought is a closer inspection and more rigid regulation of the final delivery.



A power-propelled ice scraper.

Ice is coming to be more appreciated than ever, and new uses for it are being found. The baker puts a lump of ice in his dough and gets better pie crust than in the old way. For sore throat the ice-bag is used in hospitals. Druggists and physicians know that melted natural ice-water is a better solvent than distilled water for compounding prescriptions. Ice-water works better in a storage battery than spring or bottled or "city" water. Ice is a great disinfectant. Milady rubs her cheeks with ice and gets a color that cosmetics cannot give. In frigid Winnipeg ice is stored in yards and melted for "wash day," because results are so much better than with the harder water.

The British Quick-Firing Field Gun*

A Type of the Weapons That Are So Extensively Used in the European War

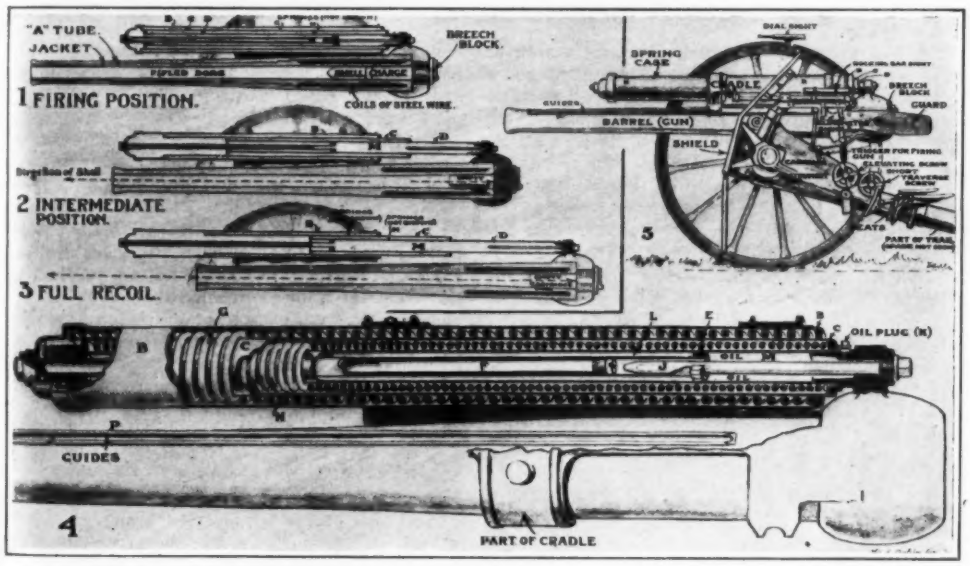
THE modern Q.F., or quick-firing gun, has been designed, as its name implies, with a view to extreme rapidity of action. As a consequence, particular attention has been given to securing the best methods of absorbing the recoil without disturbing the position of the gun-carriage, so that no time be lost in re-laying the gun after each shot. The devices adopted for this purpose are particularly interesting, as they represent the only point at which the Q.F. gun radically departs from the older types.

The British 18-pounder Q.F. gun is built up from three main components (Fig. 5; limber not shown): (1) The barrel, with the loading and firing devices; (2) The carriage, with sighting, laying, and recoil fittings; (3) The limber, with the magazine for carrying ammunition. The barrel consists of a central nickel-steel tube, known as the *A* tube (Fig. 1), having its breech end strengthened by layers of steel wire closely coiled round it at the position where it has to resist the maximum force of the explosion (see Fig. 1). The *A* tube is pressed into an outer tube, also of nickel steel, called the jacket.

When the barrel becomes worn, and the accuracy of the gun is adversely affected thereby, it may be restored by taking out the *A* tube and fitting a new one. The outside of the jacket is fitted with flat strips of metal, *P* (Fig. 4), on which, during recoil, the barrel slides in a suitable cradle. This is fixed to the carriage in such a manner that the muzzle of the gun can be elevated, lowered, or traversed from side to side through a considerable angle without moving the carriage.

The block to carry the loading and firing mechanism is screwed on to the breech end of the jacket. To this block is hinged a swinging door, or plug, known as the breech-block, which serves to close the opening through which the charge is inserted, and which also contains the firing mechanism, consisting of a spring-operated firing-pin, and the trigger controlling the latter.

The carriage consists of a steel axle, supported by two large wheels, carrying a steel frame extending backward, in the shape of a tube, called the "trail." The "spade" at the end of the trail is fixed, and buried in the ground when the gun is in action, so as to steady the carriage. When traveling, the trail is linked up to the limber and forms the draw-bar by which the gun is towed. The "cradle" on which the barrel slides during recoil is carried upon the upper part of the frame between the wheels, and is fitted with the telescopic sights, and with screws for the elevating, lowering, and traversing necessary when "laying," or aiming the gun.



How it works: the recoil-mechanism which makes the British field-gun a quick-firer and obviates relaying.

In diagram No. 1, the gun has just fired, and the absorption of the energy of its backward "kick" is taking place, being gradually checked by the recoil-springs. In No. 2 the recoil has progressed further. In No. 3 the springs (which are shown in detail as built into the recoil-cylinder) have been compressed by the firing of the gun to nearly fully extent. A recoil of 3 feet 5 inches is shown—not the maximum recoil, which is 4 feet 1 inch. In diagram No. 4 the complete cradle is not shown; it is broken away to make the diagram clear. The portion seen is attached to the recoil-spring case, and to the gun-carriage; not to the barrel of the gun itself. In No. 5 the "guard" is intended to prevent accidental harm happening to the gunner firing the piece, from the recoil, which, of course, is instantaneous and swift in its action.

The most interesting feature of the weapon—the device for absorbing the recoil on firing, and returning the barrel to its normal position ready for the next shot—is constructed as follows: Three tubes, *B*, *C*, and *D*, are placed concentrically, the inner tube *D* being fitted with a piston *E*, carried by a hollow piston-rod *F* which is firmly attached by way of the end cap to the outer tube *B*, the tube *B* in its turn being securely fixed to the cradle on the carriage.

The inner tube *D* is fixed to the barrel at the breech end, and moves with it during recoil, the intermediate tube *C* "floating" freely between the two. Coiled springs, *G* and *H*, are placed between the tubes *B*, *C*, and *D*, and a central rod *J* is attached to the barrel at its breech end. The inner tube *D* is filled with oil through the plug *K*.

Its action is as follows: When the barrel recoils, it carries with it the inner tube *D* (Fig. 2), and, as the piston *E* is fixed to the carriage by way of the tube *B*, these two parts cannot move with the barrel. The oil in the space *L* is therefore forced through small grooves in the piston into the space *M*, the speed of movement of the piston inside the tube, and consequently the speed of the barrel's recoil, being regulated by the size of these grooves.

When the barrel has recoiled to its full extent (Fig. 3), the compression of the spring *H* has forced the "floating" tube *C* to move until the spring *G* is sufficiently compressed to balance the pressure. When the force of the recoil is expended, the springs *G* and *H* come into action and return the barrel to its firing position, the moving parts being brought gently to rest by the action of a central plunger *J*, which, being fixed to the barrel, enters the hollow piston-rod and gradually displaces the oil therein, the passage of this oil through the small space between the rod and the tube setting up the necessary resistance.

*The *Illustrated War News*.

Definition and Classification of Lime.

STRICTLY speaking, lime is the oxide of calcium. It can be prepared by heating calcium carbonate under such conditions that the compound is decomposed, the carbonic acid is driven off as a gas, and the calcium oxide remains as lime. Calcium carbonate occurs in nature as calcite, which is the main constituent of limestone. It is almost always associated with impurities, such as silica, the oxides of iron and aluminium, and magnesium carbonate. With the exception of magnesia, these impurities may be found in almost any proportions, so that there is no sharp line of distinction between limestone on the one hand and sandstone, cement rock, or clay on the other. Any of these substances can be heated in such a manner that whatever calcium carbonate they contain will be decomposed. This makes it necessary to set an arbitrary limit by stating that the resultant product must contain at least a certain proportion of calcium oxide in order that it may be called lime. The chief physical characteristic of lime is that it will slake when treated with water. The slaking is accompanied by an evolution of heat and an increase in volume, and results in the formation of a plastic putty. It has been found that if the impurities are present in too large proportions this power of slaking is impaired or destroyed. If the ability to slake is considered as a condition which a substance must fulfill in order that it may be called lime, then experience tells us that the product of calcination of a limestone is lime only when the sum of the silica, ferric oxide, and alumina is less than 5 per cent. It has been found that magnesia does not impair the slaking power of the lime seriously and that the presence of this substance improves the quality of the lime for many purposes. From a commercial standpoint, magnesia is not considered as an impurity, and limes are classified according to their composition as follows:

CLASSIFICATION OF LIME.

High-calcium lime contains 0 to 5 per cent magnesia.

Magnesian lime contains 5 per cent to 25 per cent magnesia.

Dolomitic lime contains 25 per cent to 45 per cent magnesia.

Superdolomitic lime contains over 45 per cent magnesia.

This classification is the one officially adopted by the National Lime Manufacturers' Association.—*Mineral Resources, 1913, United States Geological Survey.*

The Therapeutic Uses of Preparations of the Ductless Glands—II*

Notes on Experimental Investigations of Undoubted Future Value

By Robert G. Torrey, M.D.

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 2068, Page 123, August 21, 1915

HYPOPHYSIS.

THE functions of the hypophysis have of recent years been the subject of an immense amount of research, and some few facts seem to be definitely established.

Like the suprarenal gland, the hypophysis consists of two principal parts, differing in their derivation and function. The anterior lobe, or pituitary gland, is an epithelial structure, while the posterior lobe is an outgrowth of the third ventricle and consists principally of nervous tissue. The fact of there being an active internal secretion is well established. There may also be an external secretion into the third ventricle having a direct effect on the central nervous system. So little is known regarding the physiology of the third portion, the pars intermedia, that a discussion of this subject will not be undertaken. Important facts noted regarding the effect of the gland on development and growth have been the association between changes in the hypophysis and acromegaly, which condition seems to be due to overactivity of the gland in adult life; a connection between the overactivity of the gland in early life and gigantism or overgrowth of the long bones; and a relation between insufficient function of the gland and the condition described by Froelich as dystrophia adiposogenitalis. In certain cases of dwarfism, the anterior lobe of the hypophysis is said to be destroyed. There is a very close connection between the hypophysis and growth, especially of cartilage and bone, also between the hypophysis and other glands of internal secretion, especially the thyroid and the sex glands. Changes in the hypophysis seem to have a direct effect on carbohydrate metabolism. With insufficient glandular activity there is a marked retardation of growth and retention of infantile characteristics. It is impossible to say how much of this effect is due directly to the hypophysis, and how much of it results from interference with other glands.

It has long been considered that there is an action between disorders of the pituitary body and diabetes insipidus. This is probably not the case except in so far as growths of the hypophysis cause pressure and disturbance to the base of the brain and the floor of the third ventricle.

Like the suprarenal body, the hypophysis contains two principal portions functionally distinct. With the adrenal it is practically impossible to separate the two portions of the gland, and extracts of the whole gland must be employed. With the hypophysis, on the other hand, the lobes are easily separated, and preparations of the whole gland, or of either the anterior or posterior portions, are available.

The action on growth and development seems to depend largely upon the anterior portion, while the immediate effect upon the blood-vessels and smooth muscle appears to result from the activity of the posterior substance. Commercial pituitrin is the extract of the posterior lobe put up in liquid form. The whole gland is available in dried form, and these products seem to be reliable. The use of these products is becoming very generally recognized.

In pituitrin, used hypodermically, we have a potent weapon against shock and collapse. Its effect on vasomotor tone is very satisfactory in conditions of circulatory paresis. In many ways it seems the most satisfactory drug available in emergencies, such as pneumonia, erysipelas and other acute infections, and following operations. The direct effect upon the heart tone seems to be favorable.

As a stimulant to the smooth muscle structures if acts promptly, which accounts for the favor it enjoys among obstetricians, who accord it a place above ergot in furthering contractions of the uterus. In asthenic conditions with paresis of the bowel and otherwise uncontrollable distention, an injection of pituitrin may be followed within a few moments by a regaining of intestinal tone and expulsion of quantities of flatus. It appears to have a pronounced effect as a diuretic and is much used for this purpose. A great deal of experimental work has thus far failed to satisfactorily establish the mechanism of this action. There is probably some effect apart from the increase in blood-pressure.

Pituitary gland is said to have a favorable action in uterine atony, uterine hemorrhage, and in various chronic non-inflammatory gynecologic infections. The treatment here seems to result in a lessening of pelvic congestion, depending on improved vessel tone, muscle tone, and possibly on a resulting change of ovarian activity, as the hypophysis seems to exercise a definite influence on the activity of the sex glands.

Among the conditions for which extracts of the hypophysis have been recommended is acromegaly, in which the whole gland is preferred; the effect in this condition probably being due to the anterior portion, or the true pituitary. A number of cases have been reported in which results were favorable, using from six to twelve grains daily of the dried gland. There are probably many cases showing a mild degree of hypoactivity of the pituitary which can be benefited by a gland administration. These cases are apt to show an increased carbohydrate tolerance, and, in fact, it is claimed that the proper dosage may be determined by testing for alimentary glycosuria after the giving of dextrose or levulose in the amount which should cause glycosuria in a normal individual of the same body weight, decreasing the dose causing a cessation of the glycosuria, while increasing the dose of hypophysis causes sugar again to appear in the urine. In cases of dystrophia adiposogenitalis, improvement in condition has not been as marked as in cases of acromegaly. This seems natural, as the developmental faults are of earlier origin, and normal growth in these cases has never been reached, while in the acromegalic the condition is of later life and is implanted on a normally developed body.

It is not unusual to find girls or young women of faulty development with a marked uterine atony and a troublesome discharge, which seems due to muscular relaxation, and in whom the administration of the dried gland in a dose of about four to six grains daily is followed by a prompt improvement.

I recently saw a child of fourteen in whom the onset of menstruation was followed by a troublesome metorrhagia, this having lasted for twelve weeks. The girl was intensely anemic and very weak. After two days of pituitary treatment the bleeding had practically stopped. On discontinuing the gland administration there was a return of the trouble, though not as severe as before. On resuming the treatment there was again a prompt cessation of the bleeding. Since the second brief course of treatment her periods have established themselves regularly and the metrorrhagia has entirely disappeared. She has had no other medication. She is now comparatively strong and her appearance excellent.

Pituitrin has been said to be an active galactagogue, but experiments have shown that this apparent action is caused by muscular contraction of the ducts causing a discharge of milk, but that there is no increased secretion.

It has been recommended in osteomalacia, although the reports of its use do not show as much evidence of favorable action as do those of suprarenal medication. In shock it may be combined with epinephrin, the resulting increase of blood-pressure being better sustained than when either is used alone. In pulmonary hemorrhage it seems theoretically indicated, since, as has been shown by Wiggers, it raises the general blood-pressure but causes no rise of pressure in the pulmonary circuit.

The pituitary gland is recommended in angioneurotic edema, urticaria, and asthma, also in hyperthyroidism.

On the whole, it may be said that pituitrin, the extract of the posterior lobe, is useful in emergencies in certain conditions, being one of the most valuable of agents at our command for temporary use. No conditions, however, appear where its continued employment seems advisable. The extract of the whole gland, on the other hand, containing the anterior portion, seems to have certain effects which render it useful in conditions of general faulty development and poor bodily tone.

Regarding the dangers of the uses of pituitrin, many bad results have been reported from its use in obstetrical practice; rupture of the uterus having occurred a number of times from its injudicious employment. As with any potent instrument, it must be used with judgment and common sense. I have had no experience with this phase of its employment, but the opinion of obstetricians familiar with its use seems to indicate that it is, if properly used, no more dangerous than ergot, and much more prompt in its action; the use of small doses by mouth seems to be without bad effect. Musser has tested the effect of continuous administration of the gland on a number of normal individuals, and finds the only consistent effect to be a distinct rise in blood-pressure. Large doses may cause diarrhea and gastric disturbances. The extract of the posterior lobe is conveniently put up in ampoules for subcutaneous use. Ten to fifteen minims, injected in a muscle, is the usual dose. One cubic centimeter of pituitrin corresponds to one-tenth of a gramme of the posterior lobe. The dried gland may be employed by mouth in doses of from three to six or eight grains daily. In acromegaly it is recommended in slightly heavier doses.

THE SEX GLANDS.

The ovary and testicle contain cells of two distinct types—those forming the gland structure proper and the so-called interstitial cells.

It appears conclusively established that the essential elements for influence on growth and metabolism lie in the interstitial cells; at least in the testicle is this the case. In the ovary experimental work is less conclusive on this point, though the substance of the corpus luteum has been shown to have a very definite effect on the uterus, and indeed the corpus luteum may be considered as a gland of internal secretion.

It seems peculiar that while the results of experimental work are more conclusive in showing the effect of testicular extracts on bodily growth, and in showing a distinct relation between the activity of internal secretions of the testicle and the function of other internal secretions, notably those of the thymus, pituitary, and thyroid, clinically the ovarian preparations are much more widely used.

Regarding testicular extracts, the experiences of earlier years, when experimentation along these lines seemed much in vogue, have resulted in nothing of value. The use of ovarian preparations, however, is said by many observers to be effective; especially substances derived from the corpus luteum are at the present day enjoying favor. Favorable results are reported by so many men of eminent standing that it appears impossible to deny the efficacy of ovarian substance as a therapeutic agent. Its principal uses seem to be in combating the disagreeable results of the menopause, both when it occurs naturally and when it is premature following operation, and in cases of genital hypoplasia and anemia in girls and young women. Many other uses are suggested by various authors, but reports of benefit are either few in number or not convincing.

The importance of having reliable extracts or preparations, and of careful supervision and graduation of dosage, must be emphasized. The corpus luteum preparations, and particularly those from the pregnant animal, seem the most potent. The dose recommended is from two to eight grains of the corpus luteum dried substance three times daily.

It is said at times to produce headache, vertigo, and other disagreeable symptoms, and to lower the blood-pressure if used continuously or in large doses. The effect should be carefully watched.

Most of the experience with this preparation is reported by gynecologists. Personally my experience has been limited, and I have not been able to assure myself of any certain results in the cases in which I have tried this agent.

THE THYMUS GLAND.

The thymus gland is of epithelial derivation, but added to it in its development are masses of small cells resembling lymphocytes, the true nature of which is undetermined. The thymus gland is of great importance in controlling bodily growth and development.

The removal of the thymus seems to interfere with the calcification of bone and often to cause a softening of bone already formed, the bone changes resembling, more or less, those of the rickets.

The recent experiments of Gudernatsch are very suggestive. He fed tadpoles upon thymus gland and also upon thyroid. He finds that the thymus causes a great increase in size and a prolongation of the periods of growth without mature development, while the thyroid, on the other hand, causes a rapid change to the mature form, but a retardation of growth.

In castrated animals the thymus is much larger than in the normal, and in young animals in which the thymus has been removed the growth of the testicle is more rapid than normal. Persistent enlarged thymus

* *The Therapeutic Gazette*

occurs in the so-called status thymico-lymphaticus. In infants it may have a direct mechanical influence by pressure in producing sudden death.

In children of an older growth the presence of the gland itself has not been shown to be significant in causing the sudden death which is so apt to occur in this condition. There is probably present here a general disturbance of the glands.

The practical use of preparations of thymus gland in therapeutics has been rather limited. The only condition in which favorable results seem to be reasonably established are certain types of osteoarthritis, where its influence seems good, and in rickets, in which also good results have been reported by a few observers. This gland is prepared in dry form, in tablets representing five grains of the fresh gland, and is recommended in dose of two or three tablets three times a day. Prolonged administration is said to be necessary to achieve any result in arthritic conditions.

Very little is known regarding the function of this gland. Conclusions regarding its physiological function are so meager that there is really at present no satisfactory basis for its use, except in the conditions above stated.

THE PINEAL BODY.

The pineal gland must be mentioned. Experimental work showing a profound effect on growth and bodily development is so striking that we must look for most interesting developments in the near future.

McCord concludes that feeding young animals on pineal tissue results in precocious bodily development, which, while rapid, does not proceed beyond normal limits, and also in precocity of mental and sexual attributes.

THE DIGESTIVE TRACT.

The pancreas seems to have an internal secretion which affects the liver and the digestive processes. Pancreatin, the dried external secretion of the pancreas, has been largely employed for years. It is advocated as a digestant. Whether it contains the active principle of the internal secretion in addition to its digestive enzymes is not known.

The intestinal mucosa is supposed also to elaborate an internal secretion and has been employed experimentally.

In conclusion it may be repeated that in the opinion of the writer the therapeutic use of the glandular products has not been sufficiently general. Careful observation will show many individuals in whom organotherapy offers valuable aid. A history of overactivity of a gland in the past may furnish the clue leading to the discovery of insufficient function at the present time, or the physical stigmata associated with glandular disorders may point the way. Frequently faulty and abnormal physical development gives us a clue, and the experimental employment of glandular therapy is surprisingly successful.

As has been previously remarked, these questions must be solved by workers in the great laboratory of general practice, and the reports of the next two or three years will give us a much clearer view-point in regarding this subject which now looks so promising.

In judging the value of reports of marked benefit resulting from the use of certain therapeutic agents, we have learned to discount the value of the judgment of the unreasonable enthusiast. We suspect unconscious bias also, where reports emanate from or are circulated by those who are financially interested in the sale of the remedy discussed. We must, however, give due credit to certain firms, both in this country and abroad, for fair-minded and valuable research in this particular line.

The amount of recent literature on this subject is too stupendous to attempt to list even the most important articles, but mention must be made of the works of Biedl and of Vincent Swale. A most interesting and well-written book, giving in small space a well-rounded résumé of the physiological work up to the current year, is Noell Paton's "Regulators of Metabolism."

The works of Cannon and of others on the adrenal function, also the writings of Hoskins, should be referred to.

Stimulus given to experimentation in these lines by the theories and writings of Sajous must also be mentioned. Reid Hunt in "Forchheimer's Therapeusis of Internal Diseases," edited by Billings and published this year, gives an excellent summary of organotherapeutics.

Who Killed Cock Robin?

Notes on the Tariff History of Coal-Tar Dyes

In the *Journal of Industrial and Engineering Chemistry* Dr. B. C. Hesse quotes two statements that have been published which, in effect, throw the blame for the present shortage of coal-tar dyes upon the American chemist and the manufacturer of chemicals, and he follows these with extracts from the reports of various tariff commissions and similar committees from 1882 forward that show "beyond doubt practically every argument advanced in 1914 as to why coal-tar dyes should theretofore *have been* made in this country, was previously presented to Congress in support of the view that they *should be* made here."

The quotations are as follows: In 1914 the textile industry said to the chemists of this country:

"The appeal of the textile industry to the chemist at present is: 'We need dyestuffs, so get busy and make them; don't hem and haw, and make excuses, but get right on the job.'"—*Journal of Industrial and Engineering Chemistry.*

Again in 1914 the dye-users said to the chemists of this country:

"Users of dyestuffs in quantity are more or less indignant over the fact that manufacturers in this country are dependent upon other countries, and Germany particularly, for the dye supply. They ask: 'Why haven't our chemical companies experimented sufficiently to produce synthetic dyes, pharmaceutical products, essential oils and synthetic perfumes, in the production of which Germany seems to have had almost a monopoly?'"—*Wall Street Journal.*

The extracts from the evidence taken before the various commissions show that an attempt was made to manufacture coal-tar dyes in this country as early as 1866, and that at the time of the first evidence quoted, in 1882, there were several concerns endeavoring to establish the manufacture of dyes, and were expending what, for that time, were considerable sums of money. In these tariff investigations the condition of affairs was clearly stated, and the assistance of the government was asked in the establishment of the industry; but the representations of the foreign manufacturers, many of which were palpably misleading, and of the textile manufacturers who used the dyes—these same men who are now so indignant because American chemists are not producing the dyes they need—were of more weight with Congress, and the American dye manufacturer was abandoned to the mercies of his foreign competitor.

In these investigations great weight was laid on the small size of the establishments then experimenting with dyes, and this appears to have impressed the commissions, who entirely ignored the fact that the competing German factories were still smaller only a few years before, but, under intelligent governmental encouragement, had rapidly grown to a position dominating the trade of the world.

The benefits to the consumer, the textile manufacturer, by a reduction of the tariff, were grossly exaggerated, for it was shown that while on the one hand the textile man consumed only between five ounces and one pound of dye to one hundred pounds of his goods, on the other hand even the small American establishments of 1882 forced a considerable reduction in the price of some of the imported dyes. A quotation from a statement by one of the manufacturers, made before a commission at the time, is instructive: "Some efforts have been made to show that the present rate of duty on these dyes is very onerous to the consumer and the public; such is not the case, however, for two reasons; first, because the branches of business consuming them are themselves protected by almost prohibitory duties, and lastly and chiefly, because the quantity of dye used per pound of cloth or yarn is almost infinitesimal. Taking the case of fuchsine, for instance, a color costing only $2 per pound, but four or five ounces are required for every 100 pounds of carpet-chain; this means a tax through present duties of only 3 or 4 cents on an average size rag carpet. The fact is that while a removal of the duties would deprive the government of a large revenue and kill the home industry outright, no one class, except the foreign manufacturer, would be benefited. This was shown a few years ago in the case of artificial alizarine. By the assistance of the consumers the duty was removed from this article, ever since which time the said consumers have to pay about as much again for the article as their foreign competitors, and the large revenue that would have resulted to our people by a duty was absorbed by the foreign manufacturers and their agents. It is, therefore, desirable that neither the government nor the consumer be again inveigled into such action on behalf of a wholly foreign industry."

Another quotation from the same witness clearly illustrates the trend of affairs at that time; and they are not altogether changed to-day: "Strange to say, although we have all of the chief crude materials in this country, it is only within the last two or three years that the production of colors exclusively from our native products has been attempted. Prior to this time a few small works had been engaged in the manufacture of a few simple coal-tar dyes, but they worked exclusively with a crude material, combined and manipulated by European skill and imported into this country, duty free, in a half-finished condition, i. e., in the form of arseniate of aniline. To produce this material, American benzoles and other coal-tar products are shipped abroad in a crude state at a heavy expense, manipulated by foreign skill and labor at another heavy expense, and returned to us still as a crude product, but largely enhanced in value. The entire profits of manipulating our own crude material have thus for years been lost to our country."

It has been claimed at various times that it was impossible to successfully manufacture coal-tar dyes in this country; but this is very fully covered by a statement made by Dr. Frederick Kochler before a subcommittee on the tariff of the Senate Committee on Finance on December 13th, 1888: "I was employed as chemist in the largest aniline-color factory in Germany and in the world from 1874 to 1883, and as such have had in my hands and am familiar with the manufacture of all aniline colors known up to that date. I subsequently was engaged for over five years in the aniline-color manufactory in this country, and I, therefore, believe myself competent to judge about the possibility or impossibility of making colors here. This gentleman having never been a manufacturer of coal-tar dyes himself, can only express the views of his friends in Germany about this matter or possibly the views they wish to impress upon your committee. If they really are convinced that aniline colors never can be profitably produced here, why are they not willing to let the American manufacturers die a natural death instead of trying to kill them quickly by having the duty removed, trying it even to the point of raising money among the German aniline-color manufacturers for that purpose? I, for my part, am firmly convinced that aniline colors can and will be made here, and, as a matter of fact, about 20 per cent of the home consumption are actually made here."

The manager of one of the great German establishments told Dr. Koehler he did not think the Americans crazy enough to lower duties on dyes—but they did, and the American consumer is now experiencing the results.

In none of the many Congressional investigations of the coal-tar dye manufacture has there been any indication of a fixed policy looking to the future, nor any logical plan calculated to build up the industry, but only the supposed exigencies of the moment have been considered, and the effect on the amount of the revenues for the time being. Indeed, the result of American tariff regulations has been to strengthen the foreign manufacturers of dyes, and enable them to continue to earn dividends of 20 to 25 per cent. Under these conditions it is difficult to see where the American textile manufacturer, for whose benefit our tariff has been supposedly arranged, has profited. In any case it is now being gradually recognized that America has, through gross neglect, failed to acquire a very valuable and necessary industry.

A Fly Exhibition

In connection with the house-fly campaign an interesting exhibition is being held in one of the buildings at the Zoological Gardens, Regent's Park, London, N.W. The exhibits illustrate methods of destroying flies and fly maggots, and the substances used for the purpose, as well as the life history of the fly. The methods of destruction which are recommended are (1) for treating rubbish-tips and manures, chloride of lime, sulphate of iron, either powdered or in 20 per cent solution, miscible mineral oil of 3 to 5 per cent strength, borax or colemanite (the latter is crude calcium borate, but not obtainable in this country), slaked lime, potassium permanganate, or sodium arsenite; (2) for use indoors, formalin, alcohol and water; (3) as deterrents, pyrethrum, paraffin, miscible oil, creosol, or carbolic acid. The following formulæ are also recommended:

I.

Sodium arsenite	2 lb.	1 lb.	
Honey		2 lb.	
Treacle	10 lb.	2 lb.	
Water	10 gals.	2 gals.	

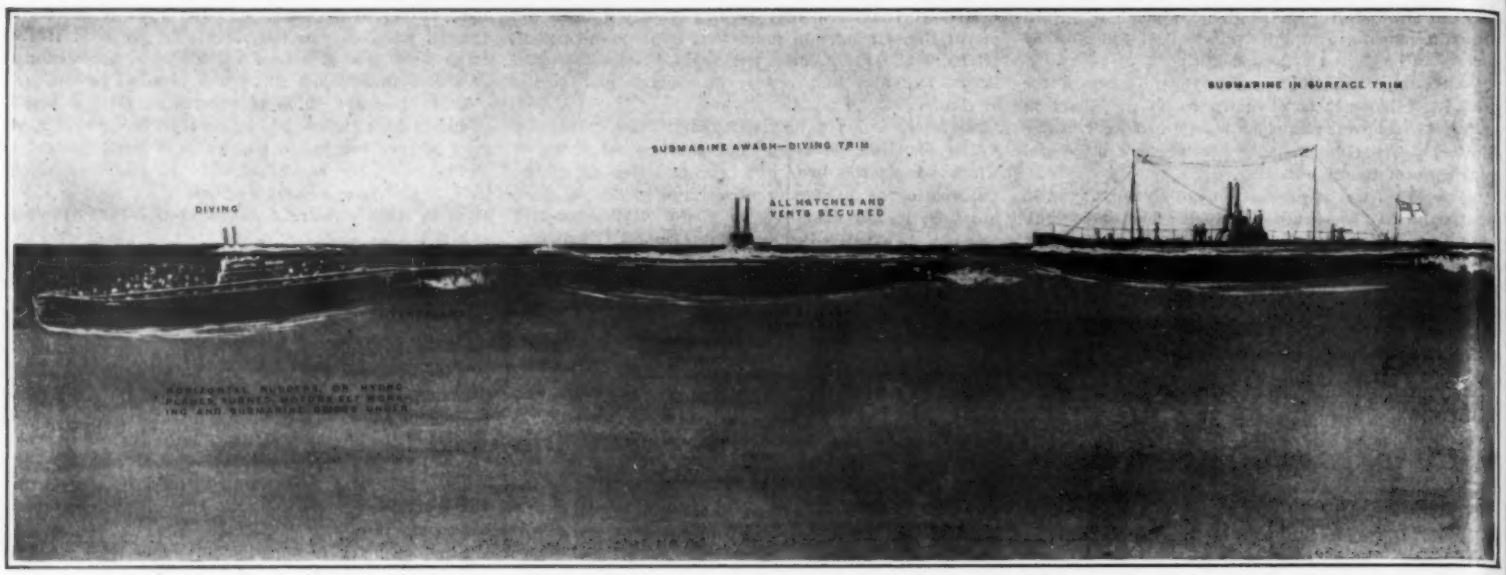
These are intended for spraying outside walls or canvas of hospitals, barracks, or tents, but must not be employed in positions within the reach of children or animals. They are used in the evening or early morning.

II.

Formalin	½ oz.	1 oz.	1 oz.
Water	1 pint	5 oz.	½ pint
Milk	—	3 oz.	½ pint
Sugar	—	1 oz.	

These solutions are distributed in shallow vessels in light places with a crust of bread placed in each vessel. These traps are set out over-night. The solutions are also employed by sprinkling on floors where animals are not likely to lick them up.

A large number of fly-traps are shown, and as baits for these are recommended (1) vinegar with sugar and a little bread; (2) formalin in conjunction with fresh beer, milk, or bread; (3) fresh beer; (4) alcohol and water (1 in 20) with bread; (5) slice of banana to increase attractiveness of fly-papers; (6) for blow-flies, a piece of meat.—*The Chemist and Druggist, London.*



Three positions of the submarine—for surface navigation; awash; and diving.

Submarines and Torpedoes*

How They Are Operated, Maneuvered and Navigated

By Lieut. C. N. Hinkamp, U. S. Navy

INTEREST in the submarine has reached a point hardly dreamed of 5 years ago. In the United States the development has been rapid. The present appropriation for the building of submarines calls for two distinct types, sea-going, of 1,200 tons, and coast or harbor-defense submarines, of about 400 tons. The contracts for these have recently been awarded. These types present added features making for increased comfort for the crew and embody many features to increase the military efficiency.

In the construction of a submarine, consideration has to be given to two kinds of tanks, namely, ballast tanks and trimming tanks. The ballast tanks are divided into main ballast tanks and auxiliary ballast tanks. The trimming tanks are tanks in the bow and stern of the boat used for trimming the vessel in the fore-and-aft line. The ballast tanks destroy the maximum part of the reserve buoyancy when completely filled. The smaller ballast tanks are used finally to trim the vessel to a predetermined amount of buoyancy. In addition to the ballast and trimming tanks the vessel is fitted with fuel tanks to carry the necessary fuel for the main engines.

The torpedo tubes are located in the bow of the submarine. In some classes there are surface tubes and tubes in the stern, but ordinarily they are fitted only in the bow. In any case, it is necessary to aim the boat whenever a torpedo is to be fired.

The engines for propelling the vessel on the surface are located in the stern as are also the main motors.

The storage batteries for submerged navigation are generally located amidships.

In the following an attempt is made to describe the use of this combination of tanks, engines, batteries and torpedoes.

It should be understood that there is nothing mysterious in the operation of a submarine. The orders used in the handling of a boat are few; they are made as comprehensive as possible and are so given as to eliminate any possible confusion.

Preparing to submerge includes all preliminary work up to the closing of the conning-tower hatch. This comprises the stowing of the deck gear, taking down the bridge, unrigging the radio, closing the hatches, unlocking the valve-operating mechanism, securing the engines; in fact, a clearing ship for action. This operation requires from 2 to 20 minutes, depending on the amount of rigging to be taken down.

Before proceeding with the description of the actual submerging of a boat, a few definitions of terms used will be given:

Positive Buoyancy.—That condition in which a boat any part of the structure of which is above water requires ballast to sink.

Negative Buoyancy.—That condition in which a submerged boat without headway requires the removal of ballast to rise.

Neutral State.—That condition in which a completely submerged vessel is in equilibrium.

Submerged Trim.—The amount of positive or negative buoyancy a vessel possesses with reference to the neutral state.

Awash Condition.—That condition in which the main ballast tanks are empty and the auxiliary ballast and trimming tanks contain the requisite ballast so that by flooding the main ballast tanks the vessel will have the proper trim for submerged operations.

Flooding.—That process whereby water is admitted to a tank directly from the sea.

Filling.—That process whereby water is pumped into a tank.

Blowing.—That process whereby water is forced out of a tank by means of air pressure.

Pumping.—Pumping water overboard from the tanks by means of main or auxiliary pumps.

The actual submerging of the boat can be done in two ways, one called the "static" dive, the other the "running dive."

In the static dive, also known as "balancing," the boat is submerged but does not move except in the vertical plane. This dive may be accomplished in two ways; by trimming the boat and maintaining her trim by adjusting the ballast, or by dropping the anchor, trimming the boat to within a few hundred pounds positive buoyancy, and the heaving in or veering on the anchor cable. The latter way is the simpler method for easy control and can be used where there is no current, or only a small amount of current, if the sea is not too rough.

The principles involved in balancing a submarine are merely those by which is determined the force of gravitation. The mass of the submarine itself amounts to several hundred tons, but the actual forces used to sink it from a neutral state are very small. The addition of 50 pounds of water will cause the boat slowly to descend. As soon as the vessel has started on its downward path it is necessary to remove part of the ballast in order to keep it from continuing on this path, provided the density of the water is constant. By pumping out, or blowing, a given quantity of ballast, there will be a force exerting an upward tendency. The determination of the amount of ballast necessary, the forces, is the difficult part of balancing. In balancing by the use of the anchor, the different forces do not have to be considered to such a great extent.

Before submerging, the vessel is generally brought to a fore-and-aft trim, which will cause the boat to be level when submerged. This is done by flooding or filling the forward or after trimming tanks.

Balancing by means of the anchor is, roughly, accomplished as follows: The anchor, which weighs about 1,000 pounds, sometimes more, is dropped. The boat is then trimmed down until it is in practically a neutral state, or has an amount of buoyancy equivalent to two or three hundred pounds. It can readily be seen that with a reserve buoyancy of three hundred pounds and a weight of a thousand pounds on the bottom there is a preponderance in favor of the anchor of about six hundred to seven hundred pounds. By slowly heaving in on the anchor cable, the positive buoyancy of the boat is easily overcome and she may be drawn down to any depth desired.

* *Journal* of the American Society of Naval Engineers.

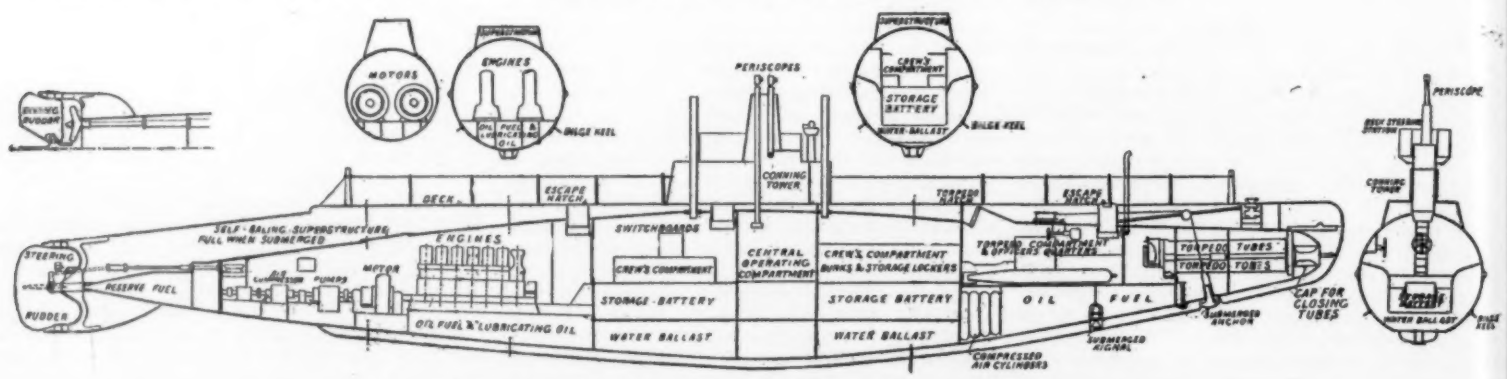
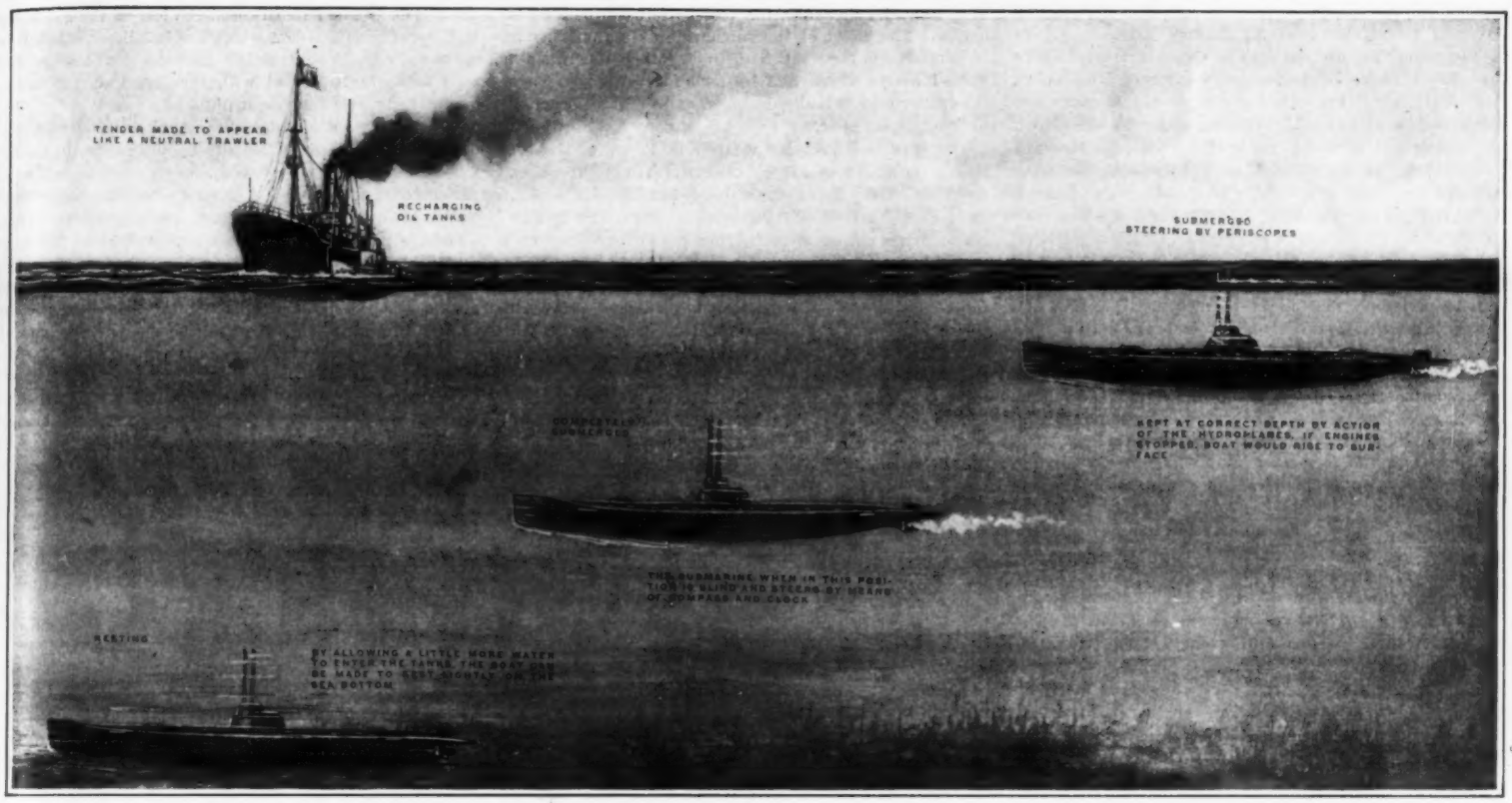


Diagram of sections of a submarine, showing interior arrangement.


TENDER MADE TO APPEAR LIKE A NEUTRAL TRAWLER
RECHARGING OIL TANKS
SUBMERGED STEERING BY PERISCOPES
SUBMERGED SUBMERGED
KEPT AT CORRECT DEPTH BY ACTION OF THE HYDROPLANES. IF ENGINES STOPPED, BOAT WOULD RISE TO SURFACE
THE SUBMARINE WHEN IN THIS POSITION IS BLIND AND STEERS BY MEANS OF COMPASS AND CHECK
RESTING
BY ALLOWING A LITTLE MORE WATER TO ENTER THE TANKS, THE BOAT CAN BE MADE TO REST SIGHTLY ON THE SEA BOTTOM

View showing a German submarine recharging its fuel tanks; traveling with the periscopes exposed; in the submerged condition; and "asleep on the bottom."

The static dive by adjustment of ballast is made as follows: After getting the fore-and-aft trim, as already described, the main ballast tanks are flooded. These tanks are flooded through large kingston valves, the operation requiring from one to two minutes. There is an enormous volume of air in the ballast tanks that must be freed before the tanks can fill with water, and the process of getting rid of this air is called "venting." The main ballast tanks "vent" overboard, as the large volume of air, if admitted into the interior of the boat, would cause the barometric pressure in the boat to rise to such a point as to be uncomfortable. All the other tanks, being comparatively small, vent inboard.

The boat being trimmed down as far as the main deck, still has too much buoyancy to run submerged. The tank next flooded is the auxiliary ballast tank. This tank holds enough water to destroy the remaining buoyancy and is flooded generally until the top of the conning tower is just under the surface of the water. The final trimming is done by slowly flooding or filling the adjusting tank. When the vessel is trimmed until there is about two or three hundred pounds of positive buoyancy, it can be readily handled submerged. This is considered the best trim for all around work, and completes the static dive. From this condition any operation submerged can be commenced.

The state of the sea affects balancing. In trimming, the boat oscillates until it strikes a condition of comparative equilibrium, when it comes to rest. With a "sea" on, this state of equilibrium is never reached, and the amount of water taken in to approach a neutral state is difficult to estimate owing to the fact that the amount of positive buoyancy depends on the area of the water-line plane which varies with every wave that passes. Suppose a vessel rising to the effect of a passing wave adds a little water in the ballast tank. As soon as the wave passes, the boat has a tendency to sink, and, with the added impetus caused by additional ballast, it falls rapidly. If the "downward send" is sufficient, the only thing that will stop the vessel is the bottom. The downward velocity may be even great enough to overcome a fairly large amount of buoyancy.

To be able to determine when to stop is almost the entire secret of the art of balancing. For stragetical purposes it is better to have a small amount of headway on the boat, just enough to overcome the effect of the sea which, being rough, would hide the wake of the periscope in the foam of the white caps.

The running dive is made from the awash condition. In the awash condition the trimming tanks and auxiliary ballast tanks are flooded to the amount necessary for the proper trim when submerged; the main ballast tanks are empty. The running dive is used for all tactical purposes except balancing.

The vessel being underway "awash," the order is given to submerge. All hands get into the boat, the engines are stopped and the electric motors started. As soon as the engines are stopped the conning tower is closed, all ventilators housed and the main ballast tank flooded. Knowledge that the trim will be approximately correct when totally submerged renders careful adjusting of ballast unnecessary. The boat is inclined slightly, about one-half of a degree down by the head, and the inrush of the water controlled by manipulation of the valves. All this is done in the short period of from one to two minutes. Seven boats have been known to average about two minutes for this evolution during maneuvers. If the control of the boat is difficult, ballast is taken on until the boat "handles" correctly.

The duties of each member of the crew are clearly defined. At least two and sometimes all the men are thoroughly familiar with each station, so that when an order is given it is intelligently and promptly carried out. All orders are repeated. When an order has been executed the fact is reported to the commanding officer. In submerging a boat all precautions are observed before flooding the main tanks, and the fact that they have been followed is reported to the commanding officer or his assistant by the men at the various stations.

Submerging a submarine is distinctly a one-man job. The commanding officer must be thoroughly conversant with all the details of the actual submerging of the boat and he must at all times be thoroughly informed as to existing conditions in the boat. None of the important features can be delegated to anyone else, as each condition or state of affairs has a distinct relation to every other condition. The second officer assigned to the submarine generally assists the commanding officer where possible, and endeavors to acquire all the information possible on the details of the operation in order that he may take charge in case of any emergency.

Navigating a submarine on the surface is just like navigating any ship of the same size, except that the displacement for amount exposed is greater. Care must be taken in making landings, as the headway is not so easily checked, due to the available power for this purpose being less per ton generally than in ordinary vessels. Navigating submerged, that is, totally submerged, is just like navigating a ship in a fog on the surface, except that when the depth is great enough there is no passing steamer and fishing craft with sleepy crews to cause worry. Navigation submerged may be compared with the flight of an aeroplane in all respects except speed and the density of the substance through which passage is made. There are, of course, no "holes" in the water as there are in the air, but there are cross currents, strata of different density and other conditions to consider. A submarine uses the diving rudders for submerging or rising in much the same manner that a hydroplane or aeroplane uses the horizontal rudders to obtain the necessary angles for rising or gliding.

Those who have observed an aeroplane in flight have, no doubt, noticed the rolling of the machine. This is apparent in a puffy wind. In a submarine running submerged we have the same condition if the water on the surface is rough. A submarine rolls a slight amount at a depth of 50 feet if the surface is *very* rough, but practically all motion is lost at a depth of 75 feet. During the recent maneuvers in the English Channel, however, commanding officers of submarines reported that it was difficult to find a depth at which there was no motion. This is readily understood, as the waters in that vicinity are somewhat shallow and the ground swells can be felt quite near the bottom.

Depth is maintained by the use of the diving rudders. Down rudder sends the stern up and the bow down. As soon as the boat is inclined downward the plane of the deck gives a large surface for the water to act on, and the power delivered to the propellers may be resolved into two components, the horizontal, driving the boat ahead, and the vertical, driving the boat downward. The amount of the vertical component of the power delivered is controlled entirely by the diving rudder. The hull is so built that normally there is a tendency for the boat to rise, brought about by the angle of the hull and the unbalanced pressures caused by inequalities in the areas of the surfaces on the bottom of the boat and on the top of the boat. This tendency must be counteracted by the trimming of the vessel and the action of the diving rudders. In some designs of submarines there are hydroplanes, forward diving rudders, and other devices to perform the same work, the difference being in diving at an angle or on an even keel.

The steering of the vessel in azimuth is done the same submerged as on the surface, using either hand or electric power. The magnetic compasses for submerged running are mounted above the hull in a composition hood and so arranged that the face of the card is reflected into the hull where the helmsman can readily see it. In recent years the gyroscopic compass has been perfected and has been installed in most of our submarines. This compass is operated entirely by electricity and the force of gravitation, both of which can be made independent of the magnetic influences of the earth. The gyroscopic compass must be adjusted for the different speeds and courses, but except for this it is automatic in its action and points in a true meridian with very little or no variation. The installation of gyroscopic compasses renders the tactical problems far simpler, as it is possible with this compass to steer the vessel within narrower limits than was possible with the magnetic compasses, owing to the fact that the action of the gyroscope is instantaneous, while the magnetic compass is very sluggish.

Control of the submarine is affected by speed. The effect of rudder manipulation varies in direct proportion to the speed of the boat. It is possible to handle a badly trimmed boat if sufficient speed is used.

It has been demonstrated that there are quite marked differences in density of water at different points and that this variation in density has a very appreciable effect on the trim and handling of a submarine. An account of an actual experience of certain United States submarines in which variation of density of water necessitated a difference of as much as 150 to 200 pounds of ballast per mile will be found in an article entitled Notes on Submarine Repairs and Operations by the

author of this paper in the *Journal of American Society of Naval Engineers* for August, 1914.

The periscopes are the eyes of the submarine. There are many styles of periscopes—monocular, binocular, stationary, revolving, rotating eye piece, stationary eye piece and "walk around." There are also devices known as omniscopes in which the entire horizon is reflected on a ground glass and any part can be separated from the rest by means of screen sectors. The periscopes are long tubes with lenses in the top and bottom and so fitted with prisms that the rays of light are paralleled. The general impression one gets is that of looking through a telescope.

The periscope that is in most general use in the United States Navy is the walk-around type with normal and magnifying eye pieces. Each boat is required to have at least two periscopes, one for the commanding officer and one for the helmsman or the second officer. In the recent boats, fitted with gyroscopic compasses, the helmsman takes his station at the compass while the lookout is at the periscope from which he directs the helmsman. The commanding officer usually stations himself at the after periscope and directs the movements of the vessel. Should he leave the periscope for any purpose, such as to consult chart or to get signals, some one always takes his place, so that there is never a time that both periscopes are not manned. When totally submerged, however, no one is needed at the periscopes for it is impossible to see more than a few feet through the water.

Signaling while submerged is a subject of much interest. In the early days of submarine navigation signaling under water was done in a most crude manner for which the hull of a vessel was found to be peculiarly adapted. Sending was accomplished by tapping on a rivet with a hammer and receiving by holding the forehead to a frame of the boat. For several years inventors have investigated and experimented extensively with the result that there are now in practical use in submarine signaling the submarine bell, the Fessenden oscillator and the vibrating wire, by which it is possible to signal effectively at distances greater than five miles under favorable conditions. All these systems set up vibrations in the water which are detected by microphones and heard through the ordinary telephone receiver.

Inventors are now endeavoring to devise means for increasing the speed of transmission.

Each submarine is equipped with one bell, some with two, and on every submerged run, in peaceful maneuvers, these bells are rung so that it is possible for those in one boat to know the approximate location of other boats. The fact that no signals were received from the *F*-4 has caused a belief that the vessel was so damaged that the crew remained alive for but a very short time after the accident which sank her occurred.

A phenomenon is the submarine "echo." The sound waves strike an obstruction, are reflected, and are picked up at the source. This could be used to determine approximately distances from obstructions, dangers, etc., but is not recommended as the possibilities of error are many.

On the surface submarines make use of the ordinary means of signaling—wig-wag, hand-semaphore shapes, flags and radio. The last is the best, but is not developed to that degree where it is absolutely reliable in submarines except under ideal conditions. However, it has proved its worth. Shape signals must necessarily be small owing to lack of space to handle them. Flag signals are inadequate for the same reason, but are carried for use in port. At night, light and pistol signals are used. Either of these systems is effective. A means of signaling which can be used very effectively both in the day time and night is the flashing of the searchlight. While it seems rather unusual to employ a light for signaling in the day time, it can be used very effectively, and occasions have arisen when signaling with a submarine at a distance could be carried on in no other way.

The equipment of a submarine for the comfort of officers and crew is not very extensive. Officers generally sleep on cots and the crew in hammocks. Ice boxes are installed on the later boats, enabling them to carry fresh meats and vegetables. Meals on these vessels are therefore more satisfactory than on the earlier boats. In addition to the fresh provisions carried, each vessel has a dry-food supply constituting an emergency ration sufficient to last 5 days. Fresh water is carried in tanks, and it is necessary that the crew be put on an allowance when at sea and that bathing be done over the side.

The submarine of the present day can operate at its maximum speed submerged for about one hour. At about one-third of this maximum speed she can operate practically twenty-four hours.

The offensive weapon of the submarine is the torpedo, or if necessity demands, the vessel itself can be used as a ram. The effect of the submarine as a ram may be illustrated by the fact that in a collision between a United States vessel and its tender several years ago, the tender was so badly damaged as to require beaching in order to save her.

The principal offensive weapon is, however, the torpedo. Ramming would be resorted to only in an exceptional case. The torpedo is an intricate mechanism built along the lines of the submarine itself, but automatic in its action after leaving the tube from which it is fired. The torpedo is divided into four main parts—the head, air flask, afterbody and tail. The head contains the explosive and the mechanisms to fire it. These heads are carried on the torpedoes only in war time. In time of peace exercise heads containing water are used. Abaft the head is the air flask. This contains the compressed air for the propelling machinery. In the next division of the torpedo is found the depth-controlling mechanism, the air superheater, the main propelling engines, the steering engines and gyroscope, and the shafting to the propellers, as well as the rods to the rudders. The tail inside contains the gear wheels for the propellers; on the outside are the supporting parts for the propellers, the diving rudders and the vertical rudders. The early torpedoes had an effective range of about 500 yards. The most modern product has an effective range of more than 10,000 yards. The development of the torpedo has been as amazing as the development of the submarine.

The operation of a torpedo is very similar to that of a submarine, except that while the submarine is operated by the crew in it, the torpedo is operated entirely by the automatic mechanism it contains.

The primary object of a submarine is to fire torpedoes, and all other considerations must be subordinated to this as far as the tactical value of the vessel is concerned, but not to such an extent as to lose sight of the fact that the torpedoes cannot be fired at a target unless the vessel arrives on the scene of action. The efforts of the crew are aimed towards one thing, sinking an enemy, and the placing of the boat in position to accomplish this end calls for the coöperation of all the departments in the boat.

An attack on a hostile vessel can be made in so many ways, and would have to be made under so many different conditions, that it is impossible to lay down any hard and fast method of procedure. The best time to attack is at dawn or twilight, or at a time when there is enough sea running to make the detection of the presence of the boat most difficult. Submarines have been known to approach within five hundred yards of a battleship in a choppy sea and in a fog to come up under the stern before being discovered, notwithstanding the fact that lookouts were stationed on the battleships to watch for the submarines. On smooth days the wake of a periscope may be picked up at a distance not greater than 5,000 yards. A submarine cannot, however, be distinguished at much more than five miles distant, at which point the boat would usually submerge and prepare to attack.

The best situation for an attacking submarine is forward of the enemy's beam and approaching her. From such a position it is possible to get within range most easily and lie in wait until the enemy crosses the path of the submarine. In such a case it is possible for the submarine to pick the time for firing with some degree of assurance that the torpedo will reach the enemy and destroy her. Should the enemy be very much faster than the submarine, tactics become a case of hare and hound, with the advantage in favor of the enemy, as the speed of a submarine is limited.

The subject of safety in the submarine has received much attention and many devices have been invented designed to obviate the dangers said to attend the operation of this type of vessel. Each designer and builder has his own method of escape for the crew in case of accident.

It is believed that the one most effective and most nearly positive means of safety is eternal vigilance. In reviewing all the accidents that have occurred in the last twenty years, hardly any are found that cannot be attributed to some one thing that could have been prevented had the commanding officer been able to correct the fault. Submarines should be so operated, and it can be done, that all except remote possibilities are provided for.

In the United States Navy officers and men on submarine duty are given a thorough course of instruction. The men are required to be thoroughly conversant with all the parts of the submarine before they are qualified to receive the extra compensation allowed for submerged runs. The officers under instructions are trained by experienced officers and are not allowed to operate alone until they have shown that they are capable of doing so. This system has worked most successfully, the recent accident that caused the loss of the *F*-4 being the first serious accident which has befallen a submarine of our Navy. The training goes on continually and all hands are impressed with the fact that submarine operation is most important duty.

It is true that accidents can and will happen, but conditions which make for catastrophe generally do not arise so rapidly that some means cannot be taken to get the boat up and the crew to a place of comparative safety before the actual accident takes place, provided, of course, that the vessel does not get beyond her safe depth. In case of accident at a depth exceeding 100 feet, the chances of getting out are remote. Even if a man escaped, he would have little chance of getting to the surface alive owing to the sudden changes of pressure.

The mental condition of officers and crew in the event of accident should receive most careful consideration in the design of any means for escape, and the aim should be to produce a device that can be operated with certainty by even the panic-stricken.

As submarine design improves, however, dangers of operation are becoming fewer. To-day the submarine possesses no more inherently dangerous features than are possessed by any ship. In fact, they are safer to cruise in than a surface craft and for the same tonnage are far more comfortable in a heavy sea.

The personnel of a submarine depend for air for breathing purposes while submerged on the free air in the boat at the time of submerging and the compressed air carried in storage flasks, which is used in freeing ballast tanks of water as well as for breathing. In the average submarine in commission to-day, the air contained in the boat at the time of submerging is sufficient to last officers and crew, numbering 18 men, for a period of from 9 to 12 hours. The air carried in the storage flasks is about sufficient to replenish the entire volume of air in the boat twice at atmospheric pressure, provided it is used for no other purpose. The maximum time during which all the air available can be breathed without serious effect is, therefore, from 30 to 36 hours. In computing this time, the safe amount of CO_2 that should be allowed to accumulate in the air at any time is taken at 2 per cent. Men vary, however, in their ability to withstand the effects of CO_2, the average man being able to withstand about 2½ per cent, while an exceptionally strong man can withstand as much as 5 per cent. Therefore, the time during which life can be sustained by the air in a given boat will depend somewhat upon the powers of resistance to the effects of CO_2 on the part of the personnel.

The air is maintained in condition for breathing by two methods: first, by slowly bleeding from the main air supply into the boat and pumping air out very slowly; and, second, by allowing the air to become foul and then pumping a part of it out of the boat and replenishing it from the air flasks, at the same time maintaining a normal atmospheric pressure in the boat. The former method has been found more economical of air. The air in the boat is kept in circulation, as it has been demonstrated by experiment that air in circulation may be charged with a much greater percentage of CO_2 than still air without evil effect on the person breathing it.

The future of the submarine opens a large field for speculation. It is believed that the size of the boats, the general design, the motive power and the principal characteristics will not change materially in the next few years, except in the case of the sea-going submarine which is now being built and which departs greatly from all previous designs.

As far as can now be foreseen, the future power of submarines may be expected to be the oil engine or some modification of it. However, engineering fields have not been sounded to their depths in the determination of adequate power for these vessels, and it is believed that the future may see some development and improvement, and perhaps a material departure from any methods of propulsion heretofore adopted or proposed.

With several flotillas of the sea-going type of submarines above to cruise with the fleet, they might one day be found in the line of battle with the destroyers. Some authorities claim that this type of submarine will eventually supplant the torpedo-boat destroyer. This is considered most improbable, however, as, owing to their shape, high speeds call for prohibitive powers, and, with the methods of propulsion now in use or contemplated, it is not reasonable to expect a speed greater than 25 knots on the surface or 15 knots submerged.

We Are Informed that the electric locomotive No. 45 of the Butte, Anaconda & Pacific Railway, described in the report of railway exhibits at the Pan-Pacific Exposition, in the last column on page 62, of the issue of July 24th, has drive wheels of 46 inches diameter, and not 56, as was there stated.

Powdered Coal

Revival of an Old Idea for Utilizing Coal Economically

At the seventh annual convention of the International Railway Fuel Association, W. L. Robinson, supervisor of fuel consumption of the Baltimore & Ohio R.R., read an interesting paper outlining the advantages that might result from the use of powdered coal in locomotive furnaces. The following extracts from this paper are reported in *Power*. The cost of fuel for the 65,000 steam locomotives in use in the United States is from $250,000,000 to $275,000,000 per annum, and now represents about 25 per cent. of the total transportation-account expenses. The fuel used is principally bituminous coal, anthracite, fuel-oil, lignite and coke. While powdered coal has been used successfully and rather extensively for years in cement and metallurgical furnaces, its use for steam-making purposes has been limited, owing to the lack of practical development. Its possibilities, however, are great, and if the practical difficulties can be overcome, the saving for the various railroad companies throughout the country will be on a corresponding scale.

Coal in a finely divided or powdered state represents the most advanced method for producing perfect combustion. While a cubic inch of solid coal exposes only 6 square inches for absorption and liberation of heat, a cubic inch of powdered coal exposes from 20 to 25 square feet, which enables the more uniform gas production from the volatile matter in the coal and the more prompt and perfect intermingling of gas and air, thereby improving combustion and reducing smoke. Furthermore, there is no cooling of the fire by heavy intermittent charges of fresh coal, as is the case with hand or stoker firing on grates.

It has been generally thought that for the burning of solid fuels in powdered form in suspension, a bituminous coal of less than 30 per cent volatile matter could not be used with satisfactory results. Mr. Robinson, however, had been informed that good results were being obtained in locomotive practice from semi-bituminous coal analyzing as low as 21 per cent volatile and having 15 per cent ash and moisture. To give the best general results and the least trouble from ash and slag, powdered coal should contain not more than 1 per cent moisture and be of a uniform fineness, so that not less than 95 per cent will pass through a 100-mesh, not less than 85 per cent. through a 200-mesh, and not less than 70 per cent through a 300-mesh screen.

COST OF POWDERING.

The cost of preparing powdered coal will vary with the cost for the raw coal and its moisture content. However, a general average from available data covering periods of the past five to ten years at cement and metallurgical plants has made it possible to present the following conservative estimate, assuming the cost of the raw coal at from $1 to $2 per short ton, and that it will require crushing and have a moisture content of from 5 to 10 per cent when placed in the drier:

Capacity of Plant in Short Tons per Hour	Average Total Cost for Preparation per Short Ton
2	From 25 to 50 cents
3	From 20 to 45 cents
4	From 16 to 40 cents
5	From 14 to 35 cents
10	From 12 to 30 cents
25	From 10 to 20 cents

The fuel required for drying the coal will average from 1 to 2 per cent of the coal dried. The distribution of the total may be approximately stated as follows:

Fuel for drying	10 per cent
Power for operation	30 per cent
Labor	30 per cent
Maintenance and supplies	25 per cent
Interest, taxes, insurance and depreciation	5 per cent
Total	100 per cent

The cost of preparing powdered coal should be more than offset by the ability to utilize mine refuse and sweepings, run-of-mine, screenings and slack grades of coal that cannot be used to good advantage otherwise, and inferior grades of sub-bituminous coals, lignite and peat of relatively lower cost per ton than the readily salable commercial fuels.

Powdered coal may be burned by either of two generally defined methods—the long-flame method, constituting a progressive burning of the coal such as is employed in cement and open-hearth furnaces, and the short-flame method, which is the latest development and is used in metallurgical and similar metal-heating work or under boilers where a similar furnace volume obtains. A combination of the long- and short-flame methods has been tried recently on a New York Central locomotive equipped for burning powdered coal.

LOCOMOTIVE MODIFICATIONS REQUIRED.

For locomotive work the principal requirements are an inclosed fuel container, means for conveying the fuel to the feeders, means for commingling the fuel with air at the time of feeding, and afterward equipment for supplying the proper amount of air to produce a combustible mixture at the time the fuel and air finally enter the furnace, a suitable refractory-material furnace in the firebox, means for disposing of the slag, means for producing the proper draft through the furnace and boiler, means for harmonizing the draft and the combustion, suitable power for operating the fuel and air-feeding mechanism, and automatic and hand control of the fuel and air regulation.

It is understood that the developed equipment for burning pulverized fuel can be readily applied to all existing modern types of steam locomotive without any changes in the boiler except to install arch brick supporting tubes, where fireboxes are not now equipped, and to remove the grates, ashpan and smokebox draft appliances. There is no equipment in the cab except the automatic hand control, which is placed in a position convenient to the fireman. The inclosed fuel container is suitable for either powdered coal or fuel oil and either kind of fuel can be used by changing the feeding equipment. The total weight of equipment applied will about equal that of the equipment removed. When not in operation the necessary draft through the boiler is obtained by the usual stack steam blower, and by exhaust steam from the cylinders when the locomotive is working. The supply of fuel is regulated according to the work the locomotive is performing, and when drifting or standing on sidings or at terminals, it can be entirely shut off. The exhaust-nozzle opening is about double the area of that used for grate firing.

Some of the advantages enumerated were the sustained boiler horse-power obtained from the use of powdered coal, the ability to increase the economical length of run, the firing of the boilers automatically with no hand-labor, the prevention of cinders, sparks, and smoke; the reduction in cylinder back-pressure due to the enlarged exhaust passages; saving in inspection, maintenance and operation through the elimination of grates, ashpans, dampers, etc.; a more uniform furnace temperature, reducing the liability of firebox and flue leakage; ability to make use of inferior qualities and grades of solid fuel; reduction of delay from cleaning or dumping fires; and a number of other factors which would tend to improve efficiency and lower the cost per car-mile.

DISCUSSION OF THE PAPER.

The paper aroused a great deal of interest, and the subject was considered of enough importance to appoint a permanent committee to keep posted on developments in this field. In the discussion some of the difficulties experienced in burning powdered coal were brought to light. The principal objection and the most serious factor interfering with the continuous operation of the locomotive was the formation of large quantities of slag, which clings to the boiler plates, fills up the tubes and forms on the superheating surface. E. H. Stroud, a maker of powdered-coal equipment, who has had considerable experience in an experimental stationary plant equipped for burning powdered fuel, explained that there were several essential factors which must be given attention to burn this coal successfully. First, it is necessary to powder the coal to the proper fineness. This is vital, because instantaneous ignition within a few inches of the burner must be obtained. Unless complete combustion is obtained at once, slag will form. The furnace must get the proper amount of air, and to insure a correct mixture mechanical means to measure the coal and air are required. Slag was an objectionable feature, but there is no occasion to permit it to get as far as the boiler tubes. All of this could be precipitated in a chamber formed by a specially constructed arch at the rear of the firebox. It was his conviction that it paid to dry the coal. This could be done while it was being pulverized. The cost of pulverizing, including power, wear and tear and attendance, at a rate of 5 to 10 tons per hour, should not exceed 15 cents per ton. Drying would add 4 to 6 cents per ton. As to a capacity of individual units, burners could be made which would burn as low as 15 pounds per hour and as high as 5,000 pounds per hour.

Joseph Harrington, who has recently become associated with the Powdered Coal Engineering & Equipment Co., of Chicago, discussed the question from the standpoint of smoke abatement. In Chicago and many other municipalities, electrification has been urged because it eliminates smoke, soot, cinders, sparks and excessive noise. Within the city of Chicago alone the cost to electrify the railroads has been estimated at $190,000,000. It would appear that the same results can be obtained by the use of powdered coal, at a cost which would be insignificant in comparison. A uniform system would be maintained on the railroads and according to an estimate by Mr. Robinson, the use of powdered coal would result in a saving on various heat losses alone of 25 per cent. This does not include savings from the prevention of smoke, soot, cinders, sparks, ash-handling, the use of inferior grades of soft coal, elimination of smoke inspectors, which in Chicago alone costs the railroads $65,000 per annum, and the solution of other problems that enter into the production of steam power in locomotives.

Electric Smelting of Copper Ores

The electric smelting of copper ores is nothing more than the substitution of electric heat for the heat derived from the combustion of carbon. Inasmuch as the carbon which is used either in the reverberatory furnace or in the blast furnace plays no important part in the reactions that take place in these furnaces, there is no reason metallurgically why electric heat may not be substituted for the heat derived from the combustion of carbon. In fact, as the authors have attempted to point out, in some cases the reactions would take place to better advantage in the neutral atmosphere of the electric furnace than in the reducing or partly reducing atmosphere of the combustion furnace. Therefore, the practicability of using the electric furnace for the smelting of copper ores would largely depend on the relative cost of coke and electric power. As the use of the electric furnace is not advocated as a competitor of the combustion furnace, but as a substitute for it, in those localities where it is not advisable, because of the high cost of fuel, to use the combustion furnace, there is no apparent reason why the electric furnace may not be developed as a substitute for the combustion furnace where the conditions are such as to warrant its use, especially in the treatment of copper-bearing ores. In this connection it is to be remembered that the development of the electric furnace in the iron industry for the reduction of iron form its ores was due to necessity. As a matter of fact, the field for the electric furnace in the reduction of iron from its ores is a limited one. Perhaps the same is true as regards the possible application of the electric furnace to the treatment of copper ores, but, judging from the comparative costs, it would seem that the possibilities of the electric furnace for the treatment of copper ores are greater than those for the treatment of iron ores, because there is not so great a difference between the cost of coke and of electric power in copper-mining districts as there is in iron-smelting centers. Also the cost of electric power is constantly becoming less, through improvements in gas engines and steam turbines, so that in districts where water power is not plentiful but cheap fuels unsuited to coke making are available, it may be found more advantageous to use electric heat than the heat derived from the combustion of coke.

As a result of their investigation, the writers are convinced that experimental work on a larger scale would lead to the development of an electric blast furnace which, in some cases, could be used to better advantage for smelting sulphide ores of copper than the combustion blast furnace.—*Bulletin 81. Department of the Interior. Bureau of Mines.*

Physical Theory of Jupiter.

In a note in *Observatory*, No. 479, T. E. R. Phillips reviews an interesting paper by H. E. Lau of Copenhagen. Lau's chief conclusions are: (*a*) Polar flattening 1:17. (*b*) The true surface of the planet consists of a bright yellow strongly reflective cloud envelope. Above this cloud envelope lies a very thin stratum, whose height is about one tenth of a second of arc. (*c*) In the upper surface strata, the daily rotation angle diminishes from the equator to the poles from 880.2 degrees to 870.3 degrees. The greatest diminution occurs near latitudes ± 7 degrees, this region making a sort of boundary between the equatorial current and the polar areas. (*d*) The regions of the equatorial zones or belts are the real spot zones of the planet. The belts consist of dark spots, the dark material of which streams partly eastward and partly poleward. (*e*) The bright spots are apparently clouds overlying the hottest places. Their brightness varies with the sun-spot activity, producing a periodic change of brightness of the planet. (*f*) The Red Spot is an abnormally heated region in the deeper strata of the gaseous envelope. The Bay is caused by the streaming outward of the higher strata over the Red Spot, pushing the material of the belt back.

The reviewer criticises some of the conclusions, particularly suggesting that the observations scarcely warrant the relation of the light spots to sun-spot activity, and a more extended series of observations is required to settle the point.

A New Way of Measuring Mental Ability

Studying the Psychology of the Individual

By A. M. Jungmann

IT was not until 1905 that a scale for measuring mental ability was put into use. In that year, an attempt was made in Paris to give abnormal children the benefit of instruction designed to fit their peculiar needs. It was decided that the intellectual ability of each child must be determined before it could obtain admission to the schools for the abnormal. There was no accepted means for giving the necessary mental examination. It was to fill this need that Binet and Simon published their first scale of tests.

The first Binet-Simon tests constituted an age-scale adapted to determine whether or not the mental development of a child was normal at its age. Before incorporating them into the scale Binet and Simon had applied these tests to different groups of children of various ages. The revised scale as it is used to-day is designed to establish the mental status of children from three to fifteen years of age. According to Binet, a child is normal if it responds successfully to the tests arranged for its age, but if it can succeed only in the tests arranged for younger children it is considered to be backward. Children who are three or more years backward are defective mentally.

AN INTELLIGENCE TEST THAT SEEMS LIKE A GAME.

The Binet-Simon tests are so arranged that the children examined do not regard the tests as an examination but look upon them more as a pleasurable game. Almost all children enjoy looking at pictures and Binet has taken advantage of this fact by the introduction of pictures in his test which the child is asked to describe. For example, a child of three should be able to enumerate the objects in the pictures shown him, but at that age it is not possible for a child to describe action. At seven years a child should be able to tell what is lacking in unfinished pictures. Other tests used by Binet consist of repetition of figures, words and sentences, the detection of an absurdity in a sentence, etc. But, as time went on and the Binet scale was used more and more its deficiencies became apparent.

A new scale was finally developed through the work done at the Psychopathic Hospital in Boston, Mass. This scale[1] is so designed that the subject examined receives credit according to the merit of his response instead of the "all or none" method of giving credit employed by Binet. The point method has the advantage of giving far more accurate information regarding the intellectual ability of the subject than the "all or none" method. In the new scale much Binet material has been employed. The following tables will give an idea of the scope of the tests:

TABLE I.

Tests.

1. *Auditory memory* for sentences, attention.
2. *Perception* (visual-of things, relations, meanings), apperception, association, imagination.
3. *Auditory memory* for words (digits), attention.
4. *Discrimination*—(a) visual, (b) and (c) kinaesthetic.
5. *Motor Coördination*, visual perception.
6. *Ideation* (association and analysis).
7. *Aesthetic judgment* involving perception, association and analysis.
8. *Perception*, apperception, visual memory, imagination.
9. *Association* (free), vocabulary, attention.
10. *Analysis and comparison* of remembered objects, attention.
11. *Memory*, imagination, attention.
12. *Practical judgment* involving memory and imagination.
13. *Imagination and command of language forms.*
14. *Kinaesthetic discrimination*, ideation (notion of series), attention.
15. *Logical judgment*, based on imagination, analysis and reasoning.
16. *Suggestibility*, visual perception, comparison.
16a. *Logical judgment*, based on analysis and reasoning.
17. *Ideation*, involving vocabulary, memory, analysis.
18. *Logical judgment*, based on analysis and reasoning, attention, memory.
19. *Visual memory*, perception, attention, motor coördination.
20. *Ideation*, involving analysis, imagination, command of language forms.

[1] "A Point Scale for Measuring Mental Ability," by Robert M. Yerkes, James W. Bridges and Rose S. Hardwick.

Fig. 1, a, b, c.—Tests of perception (relations, meanings, association, imagination).

TABLE II.

Mental Processes.	Tests.	Credits.
Motor coördination	5	4
Perception (visual)	2, 8	13
Discrimination (visual)	4a	1
Discrimination (kinaesthetic)	4b–c, 14	4
Association	9	4
Suggestibility	16	3
Memory	11	4
Memory (auditory)	1, 3	11
Memory (visual)	19	4
Imagination	13	4
Judgment (aesthetic)	7	3
Judgment (practical)	12	8
Judgment (logical)	15, (16a), 18	11
Analysis and comparison	10	6
Ideation	6, 17, 20	20

HOW THE NEW TEST FOR INTELLIGENCE IS APPLIED.

As an example of the method of scoring by points, take the test counting backward from 20 to 0. In the Binet method the subject received credit if he counted successfully, but if he made an error he did not get any credit at all. In the new scale if the subject counts successfully from 15, but makes some errors between 20 and 15, he is given a certain number of credits. If he fails to grasp the idea, he is counted a complete failure in that test, while, if he makes the count correctly, he receives more credits than if he had only counted from 15 down. The scoring by points is of great value where an individual is under observation, for every time he is examined it is possible to note accurately just wherein he has improved. In the Binet tests, it would not be possible to note the gradations of improvement with anything like the same precision as in the point scale.

The standing of a subject examined by the Yerkes-Bridges method is established by the assistance of norms in interpreting the points of credit. If the norm for a certain group of the same age, sex, race and social condition is 70, an individual who obtained a total of 80 points on an examination would be in advance of his particular group. The opposite would be evident if he received 60. He would be retarded.

The maximum number of points is 100. But, in determining norms a great difference has been found in children of the same age and sex whose social condition differs. Yerkes and Bridges made an examination of fifty-four individuals from two schools. Twenty-six boys and twenty-eight girls were selected from a school which was attended by children whose sociological condition was favorable, and the same number of boys and girls were examined in a school where the attendance was made up of children whose social environment was unfavorable. Care was taken to match the children as to age and race so that the comparison might be perfectly fair. The average score of the favored group was 37.2, while that of the unfavored group was 29.5 points. This great difference clearly indicates that children from good homes and neighborhoods surpass in mental development the children from poor homes and whose social environment is below the average, and it would be manifestly unfair to the latter to judge their mental status by the same norm as their more fortunate brothers and sisters.

ARE GIRLS BRIGHTER THAN BOYS?

From a number of experiments which have been conducted by means of the point scale, it is evident that the matter of sex is of great importance in establishing a norm. It has been found that, in the English-speaking groups examined, the girls attain higher scores than the boys at five, six and seven years of age. Between the years of seven and eleven, the boys attain the high averages and then from eleven to about fourteen the high scores go to the girls. After fourteen the boys again appear to lead.

Strange as it may seem, this condition does not exist among the non-English-speaking groups. Here, the girls attain much higher averages than the boys from the eleventh to the fifteenth year. It is apparent that economic and sociological conditions among children in city schools render the definite fixing of a sex norm impossible. It is necessary to consider many factors before establishing a norm and then it must be done, not for the

Fig. 2, a, b, c.—Aesthetic judgment, involving perception, association and analysis.

entire school population of a certain age, but for groups selected because of racial, economic and sociological conditions.

During a series of examinations certain examiners thought that there was a marked difference between the standing of Irish and Hebrew children who were tested. At first, it was thought that the Hebrew children attained a higher score than did the Irish children. Therefore, a group of forty-five Irish pupils was selected for examination from a public school and matching them in age and sex another group of Hebrew children ranging in age from four years and eleven months to sixteen years.

The result of this test showed that there appeared to be very slight difference between the two groups. The general average for the Hebrews was 2.616, and for the Irish, 2.615. It developed that the Hebrews were slightly in advance of the Irish in tests 3, 5, 8, 11, 13, 18 and 19. But the differences were so slight that the examiners do not believe that the two races cannot be fairly judged by the same norms. It is considered possible that the Hebrews may have certain language difficulties which the Irish would naturally escape because, while many of the Hebrews had been brought up to speak English, yet they were frequently of foreign parentage and heard languages other than English in their homes. To make a more satisfactory comparison psychologically between the two races, Mr. H. B. Dine is now conducting a series of experiments in examining both Irish and Hebrew children according to the point scale.

Fig. 3, a, b, c.—Tests of attention.

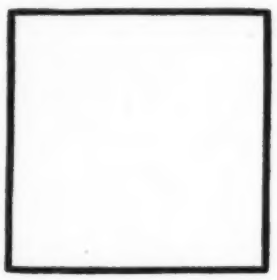


Fig. 4, a.—Test of practical judgment, involving memory.

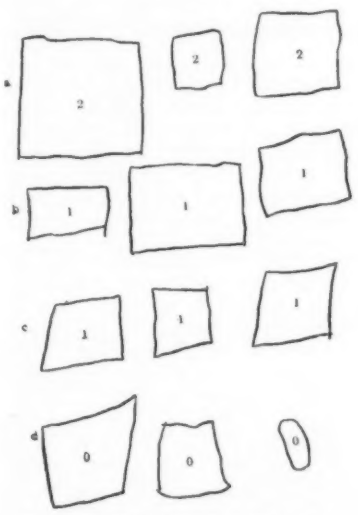


Fig. 4, b.—Result of test Fig. 4, a.

THE SOCIOLOGICAL IMPORTANCE OF THE TEST.

Because the United States is the great melting pot of the races of the world, it is the opinion of Messrs Yerkes and Bridges that careful attention should be paid to a comparative study of racial psychology. And, with the employment of the point scale as devised by them, such a study is far more practicable than it has ever been before, because it is now possible to obtain a more detailed and fair evaluation of the results of the examinations, not only of children, but of adults and both normal and pathological individuals.

The Yerkes-Bridges scale has not been tried out on school children alone, but has been used in the examination of patients in the Psychopathic Hospital in Boston, Mass. This means that it was used to establish the mental status of other than normal individuals. Here, the method of giving credits by the point system was found to be more satisfactory than the "all or none" method. An example of the unsatisfactory manner in which the Binet scale sometimes works out was the case of a sixteen-year-old boy, a social problem, who was examined at the Psychopathic Hospital. He passed all the tests at eleven years, only one at twelve and all at fifteen. In this case, his mental age may be considered either twelve or fifteen years. In the use of the point scale, with its system of partial credits and accuracy of evaluation by points, such a condition could not arise.

Professors Binet and Simon undoubtedly laid the foundation for a means of measuring intellectual ability but Messrs. Yerkes and Bridges have devised a method of obtaining far more accurate information as to the mental ability of an individual. And the point scale enables an examiner to note in detail whatever progress an individual may make between examinations, something which could not be gaged to a nicety by the Binet-Simon scale.

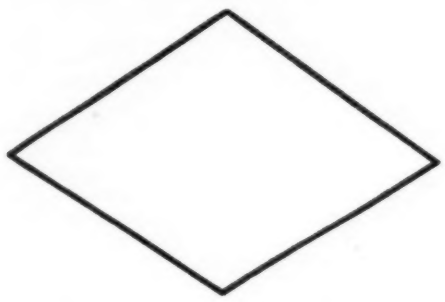


Fig. 5, a.—Another test of judgment.

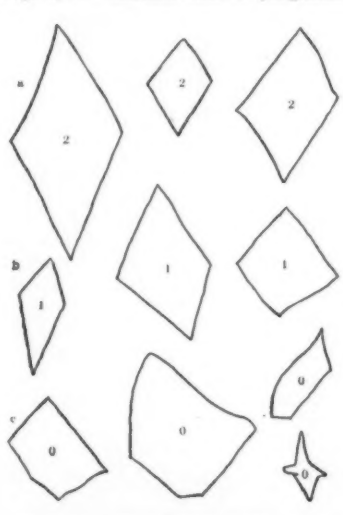


Fig. 5, b.—Result of test Fig. 5, a.

Fig. 6, a.—Test of visual perception and comparison.

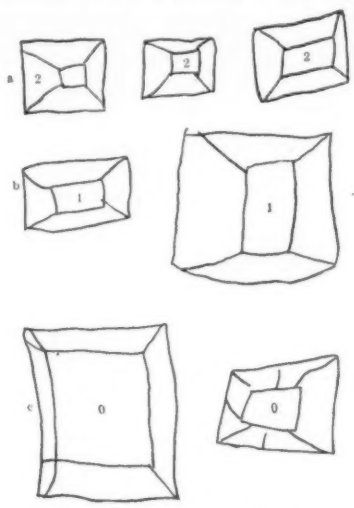


Fig. 6, b.—Result of test Fig. 6, a.

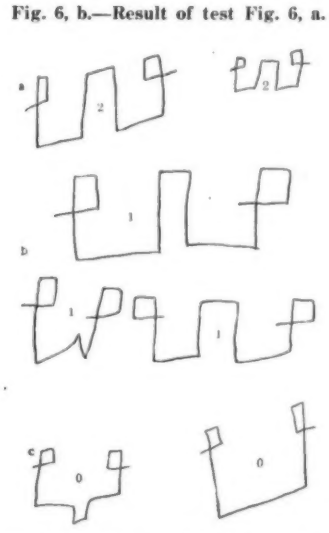


Fig. 6, c.—Result of test Fig. 6, a.

Artificial Organic Dyes

THE great volume of the dyestuffs consumed by American industries to-day consists of organic compounds, usually of very complex composition, the raw materials for which are found in the products of the destructive distillation of coal, as carried on in the retorts of gas works or ovens for manufacturing coke. The first of these artificial dyestuffs appeared a little over half a century ago, and rapidly, one after another, the natural organic dyes and the mineral dyes were displaced from their positions and reduced to minor and subordinate rank, if not forced to disappear completely from use.

The consumption of the artificial coal-tar colors in the United States has now assumed large dimensions. The increase in this consumption keeps even pace with the growth of American manufacturing industries, and more especially with the development of the various textile branches.

It has been of far-reaching influence in determining the expansion of cotton manufacture. While wool and silk were dyed with comparative facility by vegetable dyes, the contrary was the case with cotton wares. The inert character of the cotton fiber toward tinctorial substances, and the difficulty of mordanting it with metallic salts, caused a serious limitation in the range of colors and processes available for dyeing cotton materials, and greatly restricted their use. The discovery of aniline dyes, capable of dyeing cotton directly, was a notable step forward, despite the fact that these earlier products were not very fast, and could not be employed on fabrics requiring much laundering. The later discovery of the fast vat dyes of the indigo class removed this restriction on the use of colored cotton goods. To-day cotton can be dyed in every variety of tint, and the colors are practically fast, as permanent as the fiber itself. This has led to an enormous development in cotton manufacture, and the products are employed more and more extensively in houshold economy and for wearing apparel.

The great bulk of the artificial dyes is, however, used on woolen fabrics. These can not be washed frequently without suffering from shrinkage and in other ways. Hence, if intended for articles of apparel and the like, they are almost always dyed, and usually in rather dark colors. This means large quantities of dyestuff. The same rule applies to the vast amounts of woolen material absorbed by the carpet, rug, and upholstery industries. Such wares require a great consumption of acid dyes, indigo, and the alizarin colors, with smaller amounts of the other fast vat dyes. Most of the latter, involving application in strongly alkaline solutions, are in consequence not adapted for use on wool fibers.

The great diversity of modern demands for colored textiles, paper, and the like, has called for equal diversity in the dyestuffs employed, not only as regards color, but also as regards fastness to light or washing.

At present the American demand calls for over 900 different artificial dyestuffs. A small group includes colors used in very large amounts. In another much more numerous group fall colors employed in moderate but still noteworthy quantities. The majority of the dyes enumerated in current price lists are demanded in small amounts and for special purposes or qualities. This third category includes most of the very high-priced dyestuffs. The necessity of providing the great variety of colors found in this category is a dominant factor in the dyestuff industry.—*Report of Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.*

Owing to the shortage in imports of creosote, which has fallen off more than 30 per cent since last summer, American manufacturers are preparing to produce their own supplies. The consumption of creosote in 1913 was 79,000,000 gallons, largely used for the preservation of wood.

Using Air for Ballast

Theory of Vertical Control of Balloons

By R. H. Upson

GIVEN a balloon with allowance for indefinite expansion without loss of gas, it can be shown that if the temperatures and pressures, inside and out, are kept equal or proportional; then

(1) If the vessel is in static equilibrium at any height it is in equilibrium at all heights.

(2) An unbalanced static force is of the same magnitude at all heights.

By considering changes of relative temperature and pressure as causes of unbalanced force, we can change the above special case into a general law as follows:

Change in altitude can be corrected or effected without applying force, other than that occasioned by resistance and acceleration; but an unbalanced force can be corrected only by the application of an equal and opposite force.

An unbalanced force may occur from one or more of the following causes:

(1) A change in the ratio of the inside to outside pressure.[1]

(2) A change in the ratio of the inside to outside temperature.[1]

(3) An upward or downward trend in the wind.

(4) Loss of gas, or loss or gain of cargo.

In present balloons item (1) is negligible, as the gas is always maintained practically at atmospheric pressure.

Item (2) is very important, and may be due to radiation, to a change in outside temperature, or to a change in altitude.

During a quick change in altitude the condition of constant temperature ratio will be maintained only if the temperature gradient of the outside air along a vertical is just proportional to the cooling of the gas due to adiabatic expansion. For any stable condition of the atmosphere it is less. On those occasions when it is more, not only the balloon, but all the surrounding air, is in unstable equilibrium; once started in either direction, the balloon will continue to rise or fall with ever-increasing force until something is done to stop it.

The function of any control system is to counteract or eliminate the unbalanced forces. The question of altitude, or vertical steering, is of secondary importance. *The efficiency of a control cannot be gaged by the change in altitude it produces.*

COMPRESSED AIR FOR COUNTERACTING UNBALANCED FORCES.

So much by way of introduction. We are now ready to drop for awhile all thought of the cause or effect of an unbalanced force and consider only the means of eliminating it.

Ballast in some form furnishes a very efficient way, since when once attained it will exert the required vertical force without producing a drag on the speed.

Water and air are evidently the only materials available which can give a reversible process. Unlike water, air must be compressed or liquefied in order to have any effect. The first historical mention of the compressed air or high pressure balloon idea, I find in Gen. Meusnier's proposed dirigible in 1787. It is stated that the idea was proven sound, but had to be given up on account of the excessive weight involved.[2]

WEIGHT OF APPARATUS.

It can be easily shown for similar shapes and materials that the net weight of air which can be compressed, depends on the weight of the receiver and is independent of its size, or on whether it contains another gas or not; hence, instead of having separate receivers, as has sometimes been proposed, it is perfectly proper to use the balloon itself. Expressed algebraically, the increased weight of apparatus, $W' = KF$, where F is the unbalanced force to be overcome and K is a factor depending on the strength and weight of material available.

As the stress is wholly one of tension, wire can be used for getting the necessary strength. The highest tensile strength recorded in Kent is 380,000 pounds per square inch. Piano wire is given as 300,000 to 340,000 pounds per square inch. My own experience seems to confirm the lower figure even for small sizes, but to avoid any suspicion of partiality, we will base the argument on the larger value and the absurdly small factor of safety of two.[3]

ADDED WEIGHT.

For the figures given, K is about 2, which allows a small margin for extra fabric, fastenings, etc., and a deduction for the saving on the car.

Thus the added weight on a balloon must always be about twice the range of force which it is able to correct, or twice the amount of ballast necessary to correct it on a single occasion. This applies roughly[4] to all sizes and all forces. It does not matter whether it is made to take care of a large or small quantity; its comparative efficiency is the same.

COMPARISON WITH AEROPLANES.

The efficacy of an air ballast system is independent of speed. For a given effect the size of an aeroplane surface (which is the principal controlling agent on dirigibles to-day) varies inversely as the square of the speed, and the net weight of aeroplane apparatus varies roughly as the inverse speed. Thus the net weights per pound range may be expressed as 2 and $\frac{13\,3}{v}$ respectively. Equating the two terms, we get $v = 6.6$ miles per hour, as the maximum speed at which the air ballast system can appear to advantage compared to the system ordinarily in use to-day. There are many other possible agents of control that may be compared in a similar way, with the result that the air ballast system is found almost invariably to be the most inefficient of all.

AIR BALLAST CONSIDERED ALONE.

Now let us assume for the sake of argument that there are certain occasions on which other systems might be undesirable. It must be determined then to what extent air ballast may be used alone. It may be assumed at the outset that it is impossible to compromise in this way for loss of fuel on a long flight. Another important influence tending to disturb equilibrium is difference in temperature between the gas and outside air. It is this influence that the air ballast system is best fitted to handle, for when the internal temperature increases, other things remaining the same, the volume of gas may be automatically kept constant without the necessity of pumping in more air from the outside. For the light material used on free balloons this difference may sometimes be as much as 90 deg. Fahr. A conservative estimate for ordinary dirigibles is 50 degrees. It is probable that we can reduce that still further by proper construction, recent experiments indicating a possible reduction of over 50 per cent. Accurate experiments on existing dirigibles are needed to establish the absolute values.

We become involved here in a mass of figures and mathematics of which I shall only quote the results:

To take care of a possible 50-degree difference in temperature on a dirigible by means of air ballast will require never less than a sacrifice of about one half of the original surplus lift. In other words, a dirigible with provision for air ballast will never carry more than half the load that a similar ship without such a system can. And this is figured for a large dirigible of low speed and small radius of action, which conditions are the most favorable for the air ballast system.

It is claimed that the air ballast system will automatically regulate itself, that it can be set for a given altitude, and it will stay there, that the pilot may go to sleep with full confidence that the balloon will maintain its altitude.

This is true for disturbances due to fluctuation of the inside temperature. Other disturbances of equilibrium it will not counteract directly, but it will limit the change in altitude that is produced thereby *up to the limit of the fabric strength*. An 800,000 cubic foot balloon reinforced with wire to the extent of half its surplus lift will resist a vertical current of 8 miles per hour in either direction, and the difference in altitude between the two extremes will be 2,500 feet under average atmospheric conditions. Disturbances due to moisture on the envelope and change in outside temperature are also often serious, but in general, under the assumed conditions of size, safety factor, etc., I would say that it is *possible* to construct a wire balloon which will take care of all ordinary disturbing factors (except loss of fuel) which may be encountered in fair weather. With what tremendous sacrifice in general efficiency, however, is only too plain.

FREE BALLOONS.

As we have already seen, the air ballast system would be superior to the aeroplane surface for very low speeds. When the speed is zero and the condition of a free balloon is reached, the aeroplane and most other means of control available on dirigibles become wholly inoperative. Then the air ballast system may be used to advantage on certain occasions. Its weight would be prohibitive when used with coal gas; but with hydrogen it would be of advantage if the balloon were required to stay up long enough to go through two or more complete cycles of temperature change or their equivalent. For average conditions this would be something less than two days. The length of time that such a balloon could stay in the air is almost unlimited, provided it does not encounter serious storms.

LIMITATIONS OF A DIRIGIBLE.

Such an achievement would certainly attract attention, and some very remarkable records might be made, but its value when applied to a dirigible appears small, the primary object of a dirigible being not to stay in the air, but to get somewhere.

It might well be said that if we could stay in the air and save our gas, stops could be made occasionally for fuel and the flight prolonged indefinitely. The trouble with that is that if any ordinary amount of fuel is consumed between stops, *the gas cannot be saved*. Neither air ballast nor any other internal system of control is flexible enough to compensate for loss of fuel on a long flight. This may be accomplished by taking on water ballast or by making the trips sufficiently short.

In both the latter cases the gas may be saved without resorting to high pressure. This brings us to the proposition that the range of a modern high-powered balloon is limited, not by temperature conditions, but by its speed, its fuel-carrying capacity, and by the wind. The modern German balloons are especially efficient in this respect, notably the Zeppelin and Parseval. Each generally carries emergency ballast, but it is rarely necessary to lose any gas beyond that to balance the fuel consumption, even on landing, and almost never during flight. In none of the recent foreign dirigibles which I have seen, has the range and duration been calculated from anything but fuel and speed.

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[1] These two items control the relative densities. Pressure and temperature measured on the absolute scale.

[2] See Hildebrandt's "Airships Past and Present," page 46.

[3] The average factor of safety in dirigible construction is about 6.

[4] K is a little larger for ordinary present sizes.

Tillage of the Soil by Minute Living Organisms

THE soil in which plants take root and grow is the product, not of inorganic disintegration, but of continual tillage by innumerable minute organisms.

Attention was first called to the work performed by earthworms in the production of humus by Charles Darwin, in 1881. Darwin demonstrated that earthworms regularly eat earth, assimilate the digestible organic constituents and deposit the residue as excrement in little heaps on the ground. In this way they incessantly till the superficial stratum of soil and carry downward stones and other coarse parts. All of the soil passes through their bodies every two years, and it is thus loosened, fertilized and prepared for the growth of plants better than can be done by human agency. Earthworms improve the soil also by burying leaves, which rot and are then eaten by the worms.

Hence earthworms are among the most valuable of animals and they should never be killed, but their enemies, moles, field mice and the large running beetles and millipedes should be destroyed.

It has been learned quite recently that the work of the earthworms is completed, not only by bacteria, fungi and algae, but also by countless minute animal organisms, including nematodes or thread-worms, oligochaetae, tardigrades or bear animalcules, and rotatoria or wheel animalcules, which are worms less than 1/50 of an inch long.

These animal organisms, many of which are visible only when greatly magnified, are made inactive by desiccation and cold but revive when moistened and warmed, even after years of apparent death. They continually till, aerate and pulverize the soil and dispose of all decaying matter. In this work they are aided by minute and very mobile diatoms and other vegetable organisms of more than 200 known species, which inhabit the earth to a depth of a yard in such numbers that from 50,000 to 100,000 are found in a cubic centimeter of good garden soil, and from 100,000 to 150,000 in a cubic centimeter of forest soil or leaf mold. The true soil bacteria are still smaller and more numerous, so that 2,500,000 of them are found in a cubic centimeter of leaf mold. The soil bacteria produce nitrates from the ammonia resulting from decomposition, but they cannot do this until the decaying matter has been contaminated sufficiently by the larger organisms.

Numerous fungi also attach themselves to the roots of nearly all trees and many other plants, which they supply with nitrogenous products of decay in exchange for products of metabolism excreted by the tree.

So in the soil, as everywhere in nature, we find the most diverse organisms collaborating in harmony.

The Jitney Problem—I*

Its Regulation, Its Relation to Street Railways, and How They Can Meet the Movement

By J. C. Thirlwall, Railway Engineering Dept., Gen. Elec. Co.

A TRIP was made by the writer during March and April last, which included visits to a large number of the leading cities and electric railways in Texas, Louisana, Alabama, Tennessee, Arkansas, Kentucky and Ohio. More than twenty roads were visited and the question of jitney competition discussed with the chief operating officials of each, and the following paragraphs give a consensus of their opinions on the main points of discussion.

1st. The jitney car or bus is making serious inroads into the revenues of the railway companies operating in eight out of the nineteen cities visited. In two places, city ordinances regulating all common carriers had prevented their advent. In some other cities, excessive grades and poor pavements prevent any extensive use of automobiles, and in others the local officials attributed their freedom from competition to the frequency of their schedules and the high character of their service or to other purely local causes.

2d. Various methods of meeting the jitney competition have been adopted; operators in general are endeavoring to secure proper regulation either through the state legislatures or city councils; some had cut down their schedules and expenses; others had increased their service. The latter method appeared to be most effective in meeting jitney competition.

3d. Without regulation by state or city, the number of jitneys in service in a city appears to pass through a period of very rapid growth, followed by a decrease. This is due to several reasons. As a novelty, when the first machines appear, the riding in them is very heavy and they carry good loads all day long. There is a good profit in the business at this stage which attracts so many drivers that their average daily receipts drop very sharply, even though the total number of people riding in them is large enough to seriously curtail the railroad's revenues. Moreover, as the novelty of the new form of transportation wears off, as accidents increase, and as people find that they are being crowded as much or more in the jitneys as in the street cars, many passengers return to the railway. Further, the maintenance on the average small automobile, within two or three months of running 150 to 200 miles a day, becomes excessive. All these reasons combine to cause a large number of drivers to drop out, and their number usually exceeds that of fresh recruits.

But as the total number of machines decreases, the average daily earnings of those remaining tend to again increase until a point is reached where the driver can ordinarily make a profit over his costs for fuel and repairs which is sufficient to support himself and in some instances to cover the depreciation on his car.

4th. Without city or state regulation, the number of machines tends to become nearly stationary at this stage, or to decrease very slowly.

5th. The total earnings of the jitneys are considerably in excess of what the railways lose to them. They carry in pleasant weather many pleasure riders and, due to the frequency of their service, many people who would walk short distances rather than wait for a street car. The number of such riders is considerable. Moreover, they frequently charge more than five cents, particularly when operating late at night, or when asked to deliver passengers at some point off their regular routes.

6th. The larger busses, seating from ten to thirty people, have made little headway, as yet, compared to the small five- or seven-passenger car.

7th. It appears certain that even with strict regulation some autos will remain in the business, but probably at a rate of fare amounting to more than five cents, and probably only in the higher class residential sections.

8th. If regulation, particularly as to furnishing bonds to guarantee settlement of accident claims, is enforced, all but a small proportion of the jitneys will disappear.

9th. The difficulty of depending upon regulation to meet this competition lies in a fairly general public sentiment against putting the individual under the same restriction as a corporation. In many places where regulation has been proposed after the advent of the jitney, a strong protest has developed against it, on the part of many newspapers and a considerable part of the public, and in at least two cities an attempt has been made to submit the matter to a referendum vote. These factors have in general prevented the adoption or enforcement of any real regulatory measures.

10th. There are three other means of meeting the situation, until regulation can be obtained.

(a) To decrease service and cut down operating costs. This, it is realized, will simply give the jitneys a better chance, but would be adopted to bring most forcibly to the attention of the city authorities the need of protecting the railway company's interest.

(b) To put on a larger number of jitney cars or busses, to run in competition with the privately owned jitneys, and to either force the others out by giving lower fares, or, to compel regulation by the character of the competition. It is realized that this would be simply an emergency measure, that the operation of these cars would be at a loss, and that their success in driving other jitneys from business would terminate in a heavy loss on the machines which would then become useless to the operators.

(c) To increase the service on lines subject to jitney competition, and to cut down headways, with the idea of taking back sufficient passengers from the jitneys so that the narrow margin of profit to their drivers now existing would be entirely wiped out, or where they are operating at cost or less, that they would the quicker realize the hopelessness of continuing in the business.

11th. There was a wide diversity of opinion as to the merits of these schemes, but the big majority of operators declare the first scheme suicidal, in that it enables the jitneys to make a very much greater revenue, and increases still further the complaints of dissatisfied patrons.

The second scheme was also generally considered a dangerous experiment, and likely to lead to trouble with the public besides being extremely expensive and probably not very effective.

The third scheme was almost unanimously agreed to as being the logical move, but the opinions were almost equally unamimous that it would involve too great expense, both in the purchase of new cars, and in the costs of operation, especially platform wages. It was further thought by most officials that, if adopted as a means to eliminate competition, they would be compelled to maintain such service after the competition passed, thus permanently increasing expenses.

12th. It was, however, agreed that if such a measure were to be adopted, a different type of equipment from what has been purchased by most roads during the past few years would be a necessity, and that power and maintenance cost would have to be radically cut if platform wages should be appreciably increased.

13th. This led to the question of one-man cars. Nearly every operator asserted that there were certain lines in every city where one-man operation would be feasible, and that on nearly all lines such operation would be entirely practicable during many hours of the day. On the other hand, nearly every road is compelled, either by the terms of its charter or by state or city laws, to have two men on each car. However, the use of prepayment cars and the education of the public in nearly every city to this system has automatically relieved the conductor of most of his duties, and it is believed that very little delay would result from the motorman collecting fares and issuing transfers. In Lexington, Ky., the rear doors have already been closed off, the conductors are located at the front platform, and no trouble has been occasioned thereby.

But nearly everyone believed that before the change to one-man operation could be made, a long period of discussion and of agitation with city councils and state legislatures would be necessary.

14th. Almost every operator stated that if two men per car are to be used, the cost of operation will increase even with extremely light weight cars, if headways are materially shortened, and there is a very general feeling that this increase would not be made up by increased receipts. A number of operators, however, do not agree with this, saying that headways of ten to fifteen minutes apart lose a very large proportion of short riders.

15th. Assuming the use of smaller, light weight cars, however, as a future standard, nearly all were agreed on the following: Such cars would have to be of a comfortable easy riding type, which means cross seats, and prohibits the use of the short wheel base rigid single truck. The latter point was also emphasized by the general impression that cars on such trucks could not be successfully operated in trains.

The use of radial trucks with relatively long wheel base was favored by a few; most operators questioned their use on short radii curves.

Low wheels, preferably 24-inch, were favored by nearly all.

Center entrance cars were not thought desirable by most operators.

The use of multiple unit control, if cars of a seating capacity of about thirty were used, was considered a necessity by nearly all operators, in the larger cities, to care for rush hour conditions, both as a measure of platform economy and to relieve downtown congestion.

The invasion of the street railway field by the jitney automobile busses, during the past six months, brought to the attention of the railway manager more urgently than ever before the vital necessity for reducing his operating expenses. In the case of many roads, indeed, it has become a question of one of three things: a radical decrease in operating costs, an increase in fares, or a receivership. To increase fares, except by some such means as the Milwaukee zone system, is an absolute impossibility for the average city system under the present feeling of the public and legislatures. Indeed, it is becoming more and more difficult to prevent radical cuts in the rate of fare, either through being compelled to sell tickets at three or four cents, or by compulsory extension of lines or of transfer privileges.

The foregoing analysis of the jitney situation indicates that the majority of operators do not feel very confident that their interests will be adequately protected by legislation against unfair competition; before tremendous losses have been incurred. There is also a fairly general agreement that what success has attended the operation of jitneys is because they are a novelty and because they meet a popular demand for quicker and more frequent service. Most operators will further agree that the railways are not securing all of the traffic possible, and that a considerable increase in receipts could be secured by providing shorter headways and faster schedules, but that they are forced to compromise between the service which the public demands (and which they cannot afford to supply under existing conditions), and what they could most economically furnish, but which the public will not tolerate.

Under these conditions, it logically follows that on most roads, if it were possible to operate faster schedules and to greatly reduce headways without a material increase in the operating expenses, it would be hailed with equal joy by the operators and the public. It cannot be done by the automobile; there is no question of doubt, in spite of the claims of individuals, that with the typical small machine the platform costs per passenger handled and the costs of power are so much higher than on railway cars that they cannot compete on even terms. With the larger busses there appears to be a greater difference of opinion. But even with these, all experience in this country has shown that they cannot be made to pay against a properly managed electric railway; and when brought down to the simplest terms it is again the well known story of the wastefulness of small scattered power plants as compared with the large central station. An individual may operate his own automobile for short distances on city streets, and, by working from twelve to fifteen hours per day and making his own repairs and replacements, make a bare living from his machine after paying for fuel, tires and depreciation. A company attempting to operate such machines, however, could not secure his services for anywhere near the amount he is content to work for while he is operating independently. These facts are so self-evident that with very few exceptions operators have dismissed the idea of employing the gasolene car.

To put into service a greater number of electric cars of the present standard type, as a temporary measure, in order to meet jitney competition by cutting down the average daily receipts of each private car and thus hasten the inevitable conclusion of its driver that he cannot make a living in the service, would probably be effective in ending competition. But most operators fear that this would result in ordinances compelling them to maintain such service after the passing of the auto, and that the increased cost of the additional service would not be offset by correspondingly increased revenues, since platform wages, power, and maintenance charges would all advance, and at the same time the first cost of such cars would considerably increase the capital amount.

The question then arises: Can the car building companies and the manufacturers of electric car equipment design and furnish cars of a type acceptable to the public, but which will combine the qualities of light weight and strength to such a degree that the savings in power and in maintenance secured by their operation would offset the additional platform expense where more of these are used? The advance in car body and truck design, and the introduction during the past year of the low-wheel motor makes it possible to answer "yes" to this inquiry.

The Third Avenue Railway Company in New York was one of the first companies, so far as the writer recalls, to utilize this feature, and in their cars the weight per

* *General Electric Review.*

seated passenger was cut to approximately 650 pounds as compared with weights of 800 to 900 pounds in the typical double-truck cars purchased by most urban systems during the past two or three years. The seating capacity of their cars is 42; for many medium sized cities, a smaller number of seats would be ample during all hours of the day, except for one or two trips in the rush hours.

Approximately the same weight per passenger was secured in the latest cars put into service in New Orleans, which seat 52 and weigh less than 35,000 pounds. This latter car, if mounted on 24-inch wheels, using smaller motors, and taking advantage of other improvements which have lately been developed, could be brought down to about 30,000 pounds.

A still further advance has been suggested by a well known car designer, who has laid out a single-end, one-man truckless car, which seating 29 would weigh but 9,000 pounds, and a double-end car seating 32 and weighing about 12,000 pounds.

Four of the former cars would provide as many seats as five of the usual city type, and with a 30 per cent reduction in weight. Three of the second type could replace two of the standard size and weigh 50 per cent less. Either one offers considerable economies, both in first cost and in power and maintenance. The reduction in power consumption, especially in the peak load during rush hours, would be a measure of immense economy. The reduced wear and tear on tracks, roadbed, and special work would be even more marked. Reduced current means less wear on trolley wires. Reduction in brake-shoe and wheel wear is, of course, obvious.

The importance of weight reduction is so well known that a figure of five cents per pound per year is commonly accepted as the saving which can be secured in city service by any cutting of weights on the cars. If this is true, the substitution of 12,000-pound cars for cars weighing 36,000 or 40,000 pounds, even when more of the smaller ones are operated during rush hours, would save the operator from $1100 to $1700 per car annually. On the other side of the ledger is only the increased expense of platform operation for four or five hours daily, which would not amount to more than $300 or $400 per car annually.

There are, of course, other objections: first, many operators say that the public will not stand for the return to single-truck cars, with their bumping and swaying. To this the car designer replies that, by the use of a radial truck, wheel bases can be lengthened to a point where the riding qualities of the single-truck approximate those of the double-truck. He will also refer to the English coaches, with the pedestals and journal boxes mounted beneath long elliptic springs, giving a cushion effect equal to that of the automobile. Cross seats can, of course, be as easily provided as in any larger car. With these improvements, the objection of discomfort to passengers is removed.

The objection is also made that additional units on the street during the evening rush hours mean excessive congestion, slow movement and more accidents. In many cities this would be a severe handicap. Where rush hour headways are four, five or six minutes, and only single cars used, it would not be burdensome. Where they are less, and particularly where two-car trains are already required, it would involve the use of multiple unit control, and the operation of three- or four-car trains, to prevent an excessive number of units upon the street. In smaller cities, two-car trains, using platform control and jumpers, would not involve excessive complications, and might provide an increased seating capacity without shortening of headways.

But where rush hour congestion is really severe, and train operation not desired, a car of large seating capacity is essential. The 52-passenger car mentioned previously, run singly, will give a distinct saving during the periods of maximum travel, both in power and in platform wage, over ordinary equipments, and a reduction in platform cost over the small car which will offset its greater power cost unless power rates are unusually high.

One-man car operation, also, would have a much better chance of success in the smaller towns and cities than in larger places, and the smaller the car the easier it would be to use but one man.

All these things mean that local causes would govern the selection of the particular size of car that would have to be purchased, and that some operators would prefer the large capacity car and others the small car, regardless of their theoretical efficiency or relative cost of operation. A comparison, however, made from a purely economical viewpoint, *i.e.*, to determine which will leave the net revenues in the best condition, based on all costs of operation under typical conditions, becomes in order.

(To be concluded.)

Edible Wood

STRANGE as it seems, the idea of deriving food materials from wood is an old one. As far back as in 1816–17, when Europe was visited by famine, the chancellor of Tübingen University, Prof. I. H. F. Autenrieth, in fact, wrote a pamphlet on the problem ("Handbook of Wood Baking"), though nothing seems to have come of his ambitious plans.

The present war, which lends additional importance to all economical problems, has induced Prof. Haberlandt, Director of the Institute of Vegetable Physiology, at the University of Berlin, to take up the preparation of food and fodder from the wood of German forests. According to a memoir recently submitted to the Berlin Academy of Sciences, this, as it were, constitutes a storehouse of building materials for the organism, containing, especially in winter, considerable amounts of sugar, starch, fat and small quantities of albumen. These materials, however, are only found in live wood, sapwood, and the boughs and branches, whereas the heartwood of the trunks does not contain any. Moreover, their amount differs considerably according to the different kinds of wood. Soft wood, such as lime trees, birches, pines, are, in winter, nearly free from any starch, while containing considerable quantities of fat; hard woods, on the other hand, contain large amounts of starch, even in winter. According to Haberlandt's personal ovservations, the wood of these trees is made up of starchy tissues to $\frac{1}{6}$ to $\frac{1}{4}$ of their volume. From the above is seen that when eating wood large quantities of indigestible ballast are introduced into the organism, from which the digestible matter can only be derived by a thorough grinding process, crushing all the cell walls. The various kinds of woods, of course, are not equally adapted to serve as food or fodder; in the case of oak and willow, the tannin contained in the wood is in the way, and with fir and pine wood, the resin. Maple, poplar, elm, lime tree and birch are those primarily suitable as "food" trees.

Extensive investigation will, of course, be required to ascertain the exact food value of wood. Only optimists may hope ever to have pure wood meal bread adopted on a large scale, while the use of flour mixed with a certain percentage of wood meal would seem to be quite practicable. Moreover, there is every reason to suppose that wood meal will before long play an important part as fodder, provided the grinding expenses bear a favorable ratio to the food value of the product. If so, the wood-working industries will find a most advantageous market for their waste.

A Tachograph, an instrument that shows momentary variations of speed of the shaft of a machine, is of great use in detecting production losses, and is used by a large electric power company for demonstrating the value of electric as compared with engine drive.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Time System of the United States

To the EDITOR of the SCIENTIFIC AMERICAN SUPPLEMENT

The article on the "Time System of the United States" which appeared in the SCIENTIFIC AMERICAN SUPPLEMENT of June 19th contains an error in that portion which relates to establishing one single time system for the whole United States. The time of the 90th meridian, which call Chicago time, was to be used for the entire United States, or in other words, at any moment every timepiece in the United States would indicate exactly the same time. Suppose that, according to the present system of reckoning time, 8 o'clock was the time for beginning work everywhere, and suppose, further, that all timepieces in the United States will show exactly the same time. You reach your office at 8 o'clock in the morning according to the present system, and you say: "To-day is the day when the time system is to be changed and I must change my watch to indicate Chicago time. Since New York is one hour ahead of Chicago I must set my watch back one hour so that it will indicate 7 o'clock." According to the article in the SCIENTIFIC AMERICAN, you would set your watch ahead one hour and make it show 9 o'clock, but then, instead of being the same, the New York and Chicago timepieces would differ by two hours. To make them the same you must set the New York clocks back one hour and then go to work at 7 in the morning according to the changed clocks.

In Denver a man comes to work at 8 o'clock in the morning according to the present system. He is to change his watch to indicate Chicago time. Since at that particular moment the Chicago clock indicates 9, he must put his timepiece ahead one hour to make it indicate 9 o'clock and then go to work at 9 o'clock in the morning according to the changed clocks. If he should put it back one hour as you want him to do, his timepiece would indicate 7, and then, instead of being the same, there would be 2 hours difference between his time and Chicago.

In San Francisco a man comes to work at 8 o'clock in the morning according to his present system. He is to change his watch so that it will indicate Chicago time. The Chicago clock being 2 hours ahead of San Francisco, he must make his timepiece indicate 10 o'clock and then go to work at 10 o'clock in the morning according to the changed clocks. You seem to want him to put his timepiece back 2 hours and make it read 6 o'clock, but then instead of the San Francisco and Chicago clocks being the same, there would be 4 hours difference between them.

ROSCOE LAMONT.

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